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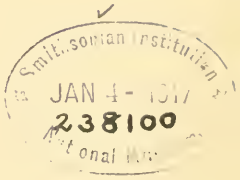

WILLIAM EMERSON RITTER
AND
CHARLES ATWOOD KOFOID
EDITORS

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A STUDY OF A COLLECTION OF GEESE OF THE *BRANTA CANADENSIS* GROUP FROM THE SAN JOAQUIN VALLEY, CALIFORNIA

BY
HARRY S. SWARTH

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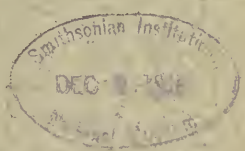

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A STUDY OF A COLLECTION OF GEESE OF THE *BRANTA CANADENSIS* GROUP FROM THE SAN JOAQUIN VALLEY, CALIFORNIA

BY
HARRY S. SWARTH
(Contribution from the Museum of Vertebrate Zoology of the University of California)

The status of the geese of the *Branta canadensis* group occurring in California has been heretofore in an uncertain and unsatisfactory condition, owing largely to a lack of specimens in collections representing the different subspecies found within the state. During the winter of 1911–1912 the Museum of Vertebrate Zoology obtained a large series of these geese from the San Joaquin Valley, California. This was part of a collection of water birds from the region collected and prepared by Mr. R. H. Beck, and acquired through the benefaction of Miss Annie M. Alexander. This material, together with skins already in the Museum collection, promised to go far towards solving the problems involved, but it required only a cursory examination of the series to show that nothing could be settled without additional specimens representing typical *B. canadensis canadensis* and *B. c. occidentalis*. The published descriptions of the last named were so much at variance with specimens at hand which were supposed to be of the race, that it was necessary to examine the type in order to have a basis for any satisfactory conclusions. Through the courtesy of Dr. C. W. Richmond, Acting Curator, Division of Birds, of the United States National Museum, these wants were supplied by loan from the collection of that institution.

In the following pages the four forms of *Branta canadensis* are discussed on the basis of the accumulated material, one hundred and

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fifty-three skins altogether. The numbers used refer, unless otherwise stated, to the collection of birds in the University of California Museum of Vertebrate Zoology.

Branta canadensis canadensis

Of specimens referable to *canadensis* proper, there are in the Museum collection thirty-five winter birds from Los Baños, California (nos. 21944–21960, 21962–21979), and one breeding bird from Lake Tahoe (no. 17224), and there were available five additional skins, one from Los Angeles County (no. 588, Grinnell coll.), and four loaned by the United States National Museum, from Rhode Island (no. 175197), North Carolina (no. 169168), District of Columbia (no. 70996), and Ontario (no. 223137), respectively.

The specimens composing our series of *canadensis* are more uniform in size, color, and markings than those of any other of the groups into which the species has been separated. The conspicuous features of this form are large size and pale coloration, especially of underparts, associated with white cheek patches continuous across throat, and absence of white half collar at base of black neck. The tarsus is usually shorter than combined length of middle toe and claw.

In the series indicated above there is but slight variation in shade of gray of underparts, the winter birds from the San Joaquin Valley, California, being of precisely the same hue as winter birds from the East. As regards color patterns, the following unusually marked birds are the only variants in the series. Three specimens (nos. 21962, 21949, 21952) show slight traces of a white half collar at base of neck, and two (nos. 21962, 21972) have a few small black spots on center line of throat, the white cheek patches being otherwise continuous with one another across throat, but in no instance are these differences sufficiently marked to cause hesitancy in placing the birds in the *canadensis* category.

Of the thirty-nine specimens in which I was able to count the number of tail feathers, one had fourteen rectrices, nine had sixteen, twenty-three had eighteen and six had twenty.

Branta canadensis hutchinsi

The *hutchinsi* series at hand forms a perfect connecting link between *B. c. canadensis* and *B. c. minima*, the gradation between *hutchinsi* and *minima* in particular being so gradual that several specimens might with equal propriety be placed in either subspecies.

Of the thirty-six specimens considered as *hutchinsi* (nos. 6497, 17241, 21961, 21980–21983, 21985–22013), twenty-five are males, eight are females, and of three the sex was not ascertained. Six have a white half collar at base of neck and a black line on throat, three have white half collar with no black throat line, twelve have black throat line with no white half collar, and thirteen have neither white collar nor black throat line. Seventeen specimens have sixteen rectrices each, while seven have eighteen. Tarsus and middle toe with claw are more nearly the same size than in the other forms of the *canadensis* group. Minimum and maximum measurements are: tarsus, 68 and 86 mm., middle toe with claw 67 and 85. Usually the tarsus is a trifle the longer.

The descriptions of *hutchinsi*, as given in literature (e.g., Coues, 1903, p. 905; Ridgway, 1887, p. 117), characterize the form as of smaller size than but otherwise similar to *canadensis*, giving no hint of its intergradation with *minima*. Our series, as stated above, forms an unbroken chain between the two forms. The series averages paler than *minima*, many specimens being quite as light-colored as *canadensis*, but there are few birds in the lot which combine the pale color, and head and neck markings of *canadensis* with the smaller size of typical *hutchinsi*, as should be the case.

A possible explanation of the intermediate character of so many of the birds wintering in California is that the breeding ground of these variants lies in the region between the habitats of typical *minima* and *hutchinsi*, and that there really is geographical continuity of range in the summer home of the two forms, correlated with gradual blending of characters in the birds occupying the middle ground. Then, if the individuals wintering in California came from the more western part of the summer home of *hutchinsi* as well as from all parts of the range of *minima*, we should find here, as is actually the case, vast numbers of typical *minima*, a lesser number of intergrades, and comparatively few typical *hutchinsi*. On this supposition we should expect to find at points farther east but few intergrades and the majority of birds typical of *hutchinsi*.

The latest authority on the distribution of North American ducks and geese (Cooke, 1906, pp. 77, 78) describes the subspecies *minima* and *hutchinsi* as occupying in part the same region during the breeding season, western Alaska and parts of the Aleutian Islands, a condition that is certainly unusual unless the two are distinct species.

Such is evidently not the case, as shown by the large number of specimens combining the characters of the two forms.

It is possible that the asserted occurrence of *occidentalis* in California is based in part upon the capture of birds of such characters as those just mentioned, for in some particulars they would answer fairly well to some published descriptions of that race. Comparison of California birds with these intermediate characters with specimens of *occidentalis* from the northwest coast region, however, shows that the affinities of the former lie in other directions, and my belief, as indicated above, is that they are intergrades between *hutchinsi* and *minima*.

Branta canadensis minima

There seems to be a greater range of variation in color and markings in this than in any of the other forms. Sixty-seven specimens were examined (nos. 19456, 19457, 21984, 22014–22077). These show the following combinations of patterns: a well-defined white mark (collar or half collar) at base of neck, and white cheeks separated by black bar on the throat, 32 specimens; with black throat bar but with no white collar, 21; with white collar but with no black on throat, 6; with neither white collar nor black throat bar, 7. These divisions have been made rather arbitrarily, for taking any one of the characters separately, every conceivable gradation may be found (see plate 1). The white collar may be merely suggested by but a few white feathers on the lower neck, or it may be a solid band of white encircling the neck, an inch or more in width. In one case the white has invaded forward so that nearly all the feathers of the fore neck are tipped with this color.

The throat may be as purely and extensively white as in *canadensis*, there may be a few flecks of black along the median line, or there may be a solid black bar. In one or two instances this bar is of such width that the white cheek markings are reduced to small, oblong patches (in no. 22026 they measure 44 by 15 mm.). These may be thickly speckled with black.

The color of underparts ranges from a uniform dark cinnamon or tawny olive to as light a gray as in any specimen of typical *canadensis*. The rectrices are usually sixteen in number; of fifty-one birds in which they could be counted, there were forty-six with sixteen tail feathers, three with fourteen, and two with eighteen.

The black neck usually shades gradually into the brown of the breast, but in some, the gray-colored birds, it is about as sharply defined as in *canadensis*. In several instances there is a well-defined black area on the upper breast, just below the white collar.

As each of the above characters varies independently of the others there is very little uniformity of appearance in a series of these birds, and, except in very general terms, it is not possible to designate for the subspecies any character of color or pattern.

The accompanying plates illustrate some of this variation. One (plate 2) figures six specimens showing white collar and black throat patch in different combinations. The other (plate 1) shows two series of selected winter specimens, illustrating, respectively, variation in extent of white collar and of black throat patch. To our present knowledge these variations in color and pattern are not correlated with any peculiarities in the geographical distribution of the subspecies, but are due to individual variation, greater in this than in any other of the races of *Branta canadensis*. To ascertain postively that this is the case, however, will require the collecting of an extensive series of *minima* upon the breeding grounds.

Altogether, the small size of *minima*, and particularly its very small bill, seem to be about its best diagnostic characters; but in this an arbitrary line must be drawn for separation from *hutchinsi*, for specimens will be found showing every degree of gradation between the two.

Comparative length of tarsus and middle-toe-and-claw seems to be a fairly dependable character, for *minima* is a decidedly long-legged bird as compared with *canadensis*. With a few exceptions in each case, it may be said that in *canadensis* the middle-toe-and-claw is appreciably longer than the tarsus, in *hutchinsi* the middle-toe-and-claw is about the same length as the tarsus, and in *minima* the tarsus is longer.

Branta canadensis occidentalis

Of this race there are in the Museum collection eight skins of use in this connection; from the Sitkan district, southeastern Alaska, four specimens (nos. 18, 19, 9916, 23245), two adult males, an adult female, and the head and neck of an immature bird; from Prince William Sound, Alaska, four specimens (nos. 1129, 1130, 1132, 1133), two adult males, an adult female, and the head and neck of another adult female.

Baird's type of *Bernicla occidentalis* (coll. U. S. Nat. Mus. no. 5994) from Port Townsend, Washington, has been available for comparison with these Alaskan specimens, and in general it may be said that all appear to belong to the same race. The differences are (1) that the type specimen has a faintly indicated trace of a white half collar at the base of the neck, which none of the Alaskan birds possesses; (2) it has a more nearly continuous line of black spots separating the white cheek patches; (3) it is of a more reddish brown color ventrally. These are all differences which, judging from more extensive series of other subspecies of *canadensis*, may well be due to individual variation, and altogether the Alaskan birds appear to be sufficiently like the type of *occidentalis* to justify the application of that name to the breeding birds of the regions where they were secured. Of the Alaska series the Prince William Sound birds are smaller and darker than those from the Sitkan district. The type of *occidentalis* is rather more reddish brown below than any of the others, the effect being produced by the broad tipping of cinnamon on the broccoli brown feathers of the underparts.

From typical *canadensis* all of these northwest coast birds differ in their exceedingly dark coloration, and although there is some variation in the specimens from different regions, as indicated above, it is nothing compared with the gap between the darkest *canadensis* and the palest *occidentalis* at hand.

In descriptive literature treating of the subject (Ridgway, 1884, pp. 456–459; 1887, pp. 116, 117; Coues, 1903, pp. 902, 904–906; etc.) stress has been laid upon the presence of the white collar at the base of the black neck, and the black line on the throat dividing the white cheek patches, these being generally cited as distinguishing characters of the race *occidentalis*. In the type of the subspecies the white half collar is barely suggested, and the black on the throat is merely a string of disconnected black spots. Of the Alaskan specimens, not one shows even a single white feather at the base of the neck, and while the black throat bar is in three cases faintly indicated by a few black spots, in the remaining five there is not a mark to interrupt the continuity of the white cheek and throat patch. Thus these supposedly characteristic markings are shown to be no more constantly present in the race *occidentalis* than they are in true *canadensis*, where a suggestion of such markings occasionally occurs.

Judging from our specimens and taking birds of the Sitkan district, Alaska, as typifying the subspecies *occidentalis*, the distinctive

characters of this form, as distinguished from *canadensis*, are: (1) extremely dark coloration; (2) slightly smaller size, that is, the maximum of *occidentalis* is below the largest *canadensis*; (3) proportionally longer tarsus.

Of six specimens of *occidentalis*, four have eighteen rectrices each, one has sixteen and one fourteen.

The greater size of *occidentalis* serves to distinguish it from *hutchinsi*. Although occasional specimens of the latter are as darkly colored as *occidentalis*, all such specimens examined are of small size, evidently intergrades between *hutchinsi* and the dark-colored *minima*.

Although in general tone of coloration *occidentalis* approaches *minima*, the difference in size between the two is in most cases so great as to render improbable any confusion of the races. This difference is to some extent bridged by our specimens from Prince William Sound, which, as mentioned above, are distinctly smaller and darker than southern Alaska examples of *occidentalis*. The region they inhabit is closer to the range of *minima*, and it is fair to believe that these specimens illustrate a step in the gradual transition between the two forms, which probably occurs. They are, however, distinctly closer to typical *occidentalis* than to *minima*.

The type specimen of *occidentalis*, in its small size, reddish coloration, and suggestions of white collar and black throat line, appears to approach *minima* even more closely than do the Prince William Sound specimens. The probability suggests itself that this bird, of intermediate character, is from some point between the habitats of typical *occidentalis* and *minima*, and a winter visitant only, at the point of capture, Port Townsend, Washington. This implies a mode of migration that is paralleled by that of other species of birds of the northwest coast region, such as with the fox sparrows (*Passerella iliaca* subspp.) and the hermit thrushes (*Hylocichla guttata* subspp.). That is, the individuals inhabiting the northernmost part of the region (as at Prince William Sound) pass over the Sitkan district immediately to the southward, and spend the winter in the southernmost parts of the humid region, while the birds of the Sitkan district either remain there throughout the year, or else move but a short distance to the southward. It is the northernmost individuals that perform the longest flights.

CONCLUSIONS

In the foregoing pages several facts have been demonstrated with a fair degree of certainty. First, in regard to the breeding bird of California: It has been generally believed that *Branta c. occidentalis* breeds south into California; the various books dealing with the subject practically agree in this notion. In Belding's "Geese which occur in California" (1892, pp. 96–101) *occidentalis* is explicitly designated as the common goose of this group in the state, and true *canadensis* is mentioned only as of possible occurrence, the author not having personally met with it. It is probable that many of the later, more general, works have taken this as their authority. It also seems highly probable that the idea was originally based on a misconception, California specimens not having been actually compared with eastern ones.

Our single summer bird, from Lake Tahoe, taken with a set of eggs (see Ray, 1912, p. 70), is, as mentioned above, unquestionably *canadensis*, furnishing a definite record for the subspecies within the state. There is also a record (Merrill, 1888, p. 143) of the breeding of *B. c. canadensis* at Fort Klamath, in southern Oregon, it being explicitly stated that *occidentalis* does not occur in the region, winter or summer. These two facts afford good grounds for the assertion that the goose found breeding throughout the lake region of southern Oregon and northeastern California is *Branta c. canadensis* and not *B. c. occidentalis*, as has been generally assumed. Moreover, this is what would naturally be expected, the general faunal complexion of the region being distinctly similar to that of the Great Basin, to the eastward, and not at all like that of the humid northwest coast region, the home of *occidentalis*.

Second, regarding the alleged occurrence of *occidentalis* in California during the winter months: In our series of the *canadensis* group of geese from the San Joaquin Valley, there are, as already shown, many typical examples of *B. c. canadensis*, and none which at all approaches *B. c. occidentalis*. In addition, it may be said that the collector of this series obtained many of his birds from market hunters, whose daily bags he had opportunities of examining, and that he was constantly on the lookout for specimens illustrating every variation of color and markings. That no example of *occidentalis* was secured means that none was seen among many times the number of *canadensis* that were actually preserved.

In this connection it may also be said that the present writer had occasion at one time, during the winter of 1903–1904, to examine several times a week the geese received by various Los Angeles dealers, and although *canadensis*, *hutchinsi*, and *minima* were seen in about the same proportional numbers as in the series of San Joaquin Valley birds under discussion, not a single specimen of *occidentalis* was ever discovered.

A critical examination of the literature wherein the white-cheeked goose has been ascribed to California, fails to reveal any definite or substantial basis for the statement. The following citations are taken from Mr. Grinnell's manuscript list of the birds of California, and refer to the subspecies *Branta canadensis occidentalis* as occurring in this state:

American Ornithologists' Union Check-List (1886, p. 127); Ridgway (1887, p. 117); Belding (1892, p. 100); American Ornithologists' Union Check-List, second edition (1895, p. 63); Grinnell (1902, p. 21); Bailey (1902, p. 68); Fisher (1906, p. 194); Cooke (1906, p. 78); Sheldon (1907, p. 187); American Ornithologists' Union Check-List, third edition (1910, p. 86); and Salvadori (1895, p. 115, as *Branta occidentalis*).

With one exception none of the writers named offers any explanation or justification for the application of the name *occidentalis* to the species treated. Belding, in his "Geese which occur in California," explicitly applied the name to the large California goose. He did not include true *canadensis* as occurring in the state, however, and apparently relied upon his memory in deciding that the birds seen were different from eastern ones. Thus he recognized but one large form of Canada goose within the state, calling it *occidentalis*, but without making any comparison with eastern material. We agree with him in so far that we also have detected but one of the two forms, but, on making careful comparison of Californian and eastern skins, have discovered no differences; hence we use the name *canadensis* for the California bird.

Thus it seems safe to assert that the oft-repeated statement regarding the occurrence of the white-cheeked goose in California has no basis in fact, or at any rate rests on no authenticated published record.

Third, as regards the status of the breeding goose of southeastern Alaska: In reports upon collections of birds from the region, made for this Museum, the name *occidentalis* was employed with some hesitancy (see Grinnell, 1909, p. 199; 1910, p. 373; Swarth, 1911, p. 47). This was principally because the birds secured did not show the definite

white collar and black throat patch ascribed to *occidentalis* in descriptive literature, markings usually likened to those of *minima*, in which they are frequently very strongly developed.

At present the conclusion to which the accumulated facts and specimens seem to point, is that there is a dark-colored, northwest coast race of *Branta canadensis*, which occupies the immediate vicinity of the coast, northwest at least to Prince William Sound, and for an undetermined distance southward, though probably not occurring in the summer farther south than the southern boundary of British Columbia. The specimen which served as the type of *Bernicla occidentalis* Baird appears to be an example of this dark, coast race, but is probably not truly representative of the form. Unfortunately some of the most variable characters have been seized upon, and used as the distinguishing marks of the subspecies, and consequently confusion has ensued in the attempt to fit the descriptions of this bird to the more normal representatives of the race.

Since so many of the water birds of the coast of southern Alaska and British Columbia are resident the year through in that general region, it is very probable that the white-cheeked goose belongs in the same category. In a letter recently received from Mr. Allen E. Hasselborg, a resident of Juneau, Alaska, and familiar with the native birds and mammals, he confirms this view, saying that the geese are about as abundant in the Sitkan district in winter as in summer. During the winter they frequent the more sheltered south- and west-facing bays and inlets, avoiding localities exposed to the cold land winds, while in summer they are of more general distribution. That this subspecies does not perform as extensive migrations as other members of the group is evident from its non-occurrence in California. If it occurs in this state at all it should be found along the extreme northern coast.

Reference to the literature treating of the geese of the *Branta canadensis* group shows very little uniformity in results arrived at by different writers. Among the various views expressed are the possibilities: (1) that these geese all belong to one exceedingly variable species; (2) that there are two species, *canadensis* with its race *hutchinsi*, and *occidentalis* with the race *minima:* (3) that there are four species, perfectly distinct, but frequently hybridizing. In this connection see Ridgway, 1884, p. 457.

Study of the series of specimens examined in connection with the present paper is strongly confirmatory of the belief expressed in the nomenclatural treatment accorded the *Branta canadensis* group in the

A. O. U. *Check-List* (1910), namely, that there is one widely ranging and exceedingly variable species, of which we can recognize four different subspecies, *canadensis*, *hutchinsi*, *occidentalis*, and *minima*. The material at hand illustrates every gradation of size, color, and pattern, from typical *canadensis* on the one hand, through *hutchinsi*, to typical *minima* at the opposite extreme. There is, however, a lack of material indicative of intergradation between *occidentalis* and the other forms, except as shown by the Prince William Sound birds, which approach *minima* in size, and by the type specimen of *occidentalis* which, as previously pointed out, also inclines toward *minima* in certain of its characters. It is highly probable that collecting in the proper regions in summer would be productive of specimens variously intermediate between *occidentalis* and *canadensis*, or between *occidentalis* and *minima*.

The presence in California during the winter months of three subspecies of *Branta canadensis*, namely, *canadensis*, *hutchinsi* and *minima*, occurring in large numbers in associated flocks, together with the presence of a fairly large proportion of intermediates with difficulty referred to any one form rather than another, is calculated to produce an erroneous impression as to the distinctness and stability of the various forms. It must be borne in mind that this is the winter habitat of races which, except where our data is inadequate, are known to occupy widely different areas during the summer months, and that it is merely the similarity of their preferences and requirements which brings the various races together in their common winter home. The same may be said of *Anser albifrons gambeli*, *Chen hyperboreus*, and *Chen rossi*, these absolutely distinct species, together with the different subspecies of *Branta canadensis*, all occurring during the winter months in exactly the same localities in California.

Birds taken upon their breeding grounds do not exhibit any such diversity of characters as is illustrated in series of winter birds taken at one locality. On the contrary, breeding birds from any one locality are wonderfully uniform in all particulars. Much remains to be learned in regard to the summer ranges of the North American geese, but such exact data as is available serves to bear out the above statement.

There are, however, published accounts of high degree of authenticity which are not clearly explicable, such as the alleged occurrence of *hutchinsi* and *minima* over the same region, in part, during the breeding season. It should be borne in mind, though, that the confu-

sion heretofore existing in regard to the respective summer habitats of *canadensis* and *occidentalis* was of exactly the same nature, and it accordingly seems probable that if the two northern forms could also be given more careful and critical study than has heretofore been accorded them, many of the discrepancies now apparent could be satisfactorily explained.

Nelson (1887, p. 84) gives the center of abundance of *hutchinsi* as along the lower Yukon and from there south to the Kuskoquim; of *minima* (l. c., p. 86), as along the Alaskan coast of Bering Sea, north to Point Barrow, and extending far inland up the rivers. Cooke (1906, p. 77) gives the summer home of *hutchinsi* as including the Alaskan shores of Bering Sea, and also the western Aleutian and the Near islands, exactly the same range as is ascribed to *minima* (l. c., p. 78).

Such statements as these are hard to comprehend if the birds are to be considered as two races of the same form, but there are so many chances for error, or for misunderstanding of data, that it seems almost certain that further careful work will demonstrate that the two forms do actually occupy separate and well-defined areas during the breeding season. It is certainly possible for migrating individuals of one form to have been captured upon the summer home of the other, while the variation in color and patterns in both forms is so great that there is chance for error in identification unless specimens be secured and examined with great care.

There appears to be a dearth of definite data bearing upon the question. The two statements cited above are of a general nature, and are not supported by mention or description of particular specimens to uphold the ideas expressed. In fact there seems to be but few instances in which this has been done. Clark (1910, p. 47) gives *hutchinsi* as the breeding goose of Agattu and Attu islands. Although specimens were not saved, descriptions are given of some which were shot and thrown away, descriptions which, as regards color and pattern, fit *minima* very well, though the dimensions given are certainly large for that form.

Bent (1912, p. 13) identifies a breeding goose from Attu Island as *minima*. Thus the statements in regard to the respective breeding ranges of *hutchinsi* and *minima* are seen to be contradictory and confusing; but, as stated above, this may well have arisen through misunderstanding of data, or misinterpretation of characters. Where we do possess more exact and abundant data, as in regard to the more

southern parts of the summer habitat of *canadensis*, or the summer home of *occidentalis*, we find no such confusion.

Reasoning from geographical grounds, and in the belief that *hutchinsi* and *minima* are two subspecies of the same species, *Branta canadensis*, the two forms should certainly not be expected to occur together during the breeding season on the same parts of the Alaskan coast of Bering Sea and on the Aleutian Islands. As *hutchinsi* is the more eastern species, every alleged occurrence of its breeding in the above region, where *minima* is known to be common, should be most fully substantiated. *Minima* is not known to occur elsewhere in summer, and it may be inferred that this is the breeding ground of the race.

Following is a list of the characters which have been used in literature in differentiating the four subspecies of *Branta canadensis*. These are compiled from the various handbooks dealing with the subject, and are those characters which have been supposed to be diagnostic.

General size	large	B. c. canadensis B. c. occidentalis
	medium	B. c. hutchinsi
	small	B. c. minima
Color of under surface of body	pale grayish, fading gradually into white of crissum	B. c. canadensis B. c. hutchinsi
	dark brown, abruptly defined against white of crissum	B. c. occidentalis B. c. minima
Triangular white cheek patches	continuous across throat	B. c. canadensis B. c. hutchinsi
	separated by black bar on throat	B. c. occidentalis B. c. minima
White collar on lower neck	usually absent	B. c. canadensis B. c. hutchinsi
	usually very distinct; always present	B. c. occidentalis B. c. minima
Number of rectrices	18 to 20	B. c. canadensis
	18 to 20	B. c. occidentalis
	16	B. c. hutchinsi
	14 to 16	B. c. minima

In testing the above characters upon the large series of geese available in the present study many proved so extremely variable as to be of no practical value, while others are based entirely upon misconceptions.

Careful examination of the series of geese at hand justifies the following diagnoses as more nearly expressing the differences existing between the four subspecies.

Branta canadensis canadensis

Size large.

Tarsus usually shorter than middle toe and claw.

Color of under surface of body pale gray; much lighter shade than back.

Black of neck abruptly defined against gray of breast.

Gray of lower surface fading gradually into white of crissum.

White cheek patches usually confluent across throat; occasionally a few black spots along median line of throat; or slight encroachment of black indicating the beginnings of the black isthmus.

White collar at base of black neck usually absent; occasionally faintly indicated.

Number of rectrices 14 to 20 (usually 18).

Measurements in millimeters. Minimum, maximum, and average of ten adult males. Wing, 418–527 (500.6); tail, 134–174 (156.8); culmeu, 47–58 (52.4); tarsus, 76–98 (92.3); middle toe and claw, 77–106 (97.3).

Branta canadensis occidentalis

Size large.

Tarsus as long as, or slightly longer than, middle toe and claw.

Color of under surface of body dark; broccoli brown, about same shade as back.

Black of neck abruptly defined against brown of breast.

Brown of abdomen abruptly defined against white crissum.

White cheek patches usually confluent across throat; occasionally a few black spots along median line of throat, or slight encroachments of black indicating the beginnings of the black isthmus.

White collar at base of black neck usually absent; occasionally faintly indicated.

Number of rectrices 14 to 18 (usually 18).

Measurements in millimeters. Minimum, maximum, and average of four adult males. Wing, 433–495 (465.7); tail, 134–154 (142.7); culmen, 48–51 (48.7); tarsus, 86–99 (92.2); middle toe and claw, 83–95 (87.2).

Branta canadensis hutchinsi

Size medium.

Tarsus about the same length as middle toe and claw.

Color of under surface variable; pale gray to dark brown.

Pattern of head and neck markings variable. Black dividing line on white throat may or may not be present. White collar at base of neck may or may not be present.

Number of rectrices 16 to 18 (usually 16).

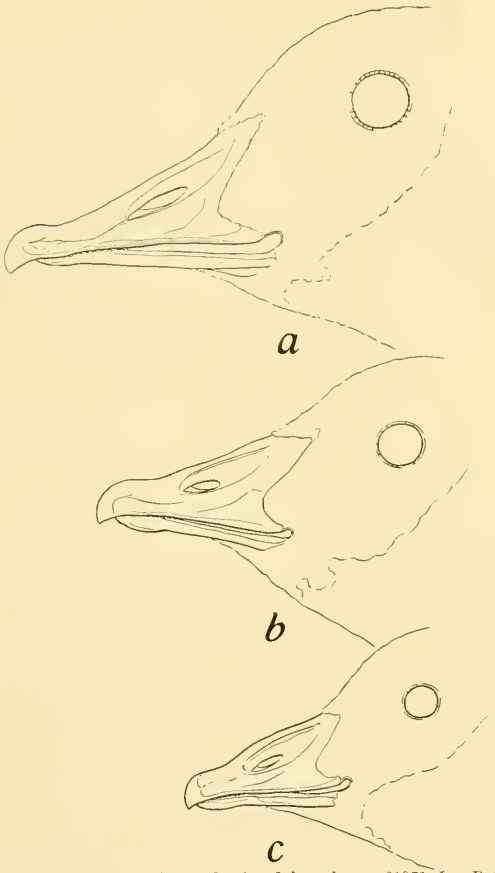

Fig. A.—*Branta canadensis canadensis*, adult male, no. 21971, Los Baños, California; lateral view of head and bill; ×0.83+.

Fig. B.—*Branta canadensis hutchinsi*, adult male, no. 22004, Los Baños, California; lateral view of head and bill; ×0.83+.

Fig. C.—*Branta canadensis minima*, adult male, no. 22018, Los Baños, California; lateral view of head and bill; ×0.83+.

These figures, approximately natural size, show the relative proportions of the bill in the three forms, one of the most reliable single characters differentiating the subspecies.

Measurements in millimeters. Minimum, maximum, and average of ten adult males. Wing, 390–455 (419); tail, 101–140 (122.1); culmen, 34–45 (39.4); tarsus, 68–86 (77); middle toe and claw, 67–85 (73.5).

Branta canadensis minima

Size small.

Tarsus much longer than middle toe and claw.

Color of under surface variable; pale gray to dark brown.

Pattern of head and neck markings extremely variable; black dividing line on white throat may or may not be present; white collar at base of neck may or may not be present. Every possible combination of the above patterns and colors.

Number of rectrices 14 to 18 (usually 16).

Measurements in millimeters. Minimum, maximum, and average of ten adult males. Wing, 337–421 (385.3); tail, 94–128 (111.7); culmen, 26–36 (30.8); tarsus, 61–81 (72.9); middle toe and claw, 55–76 (64.60).

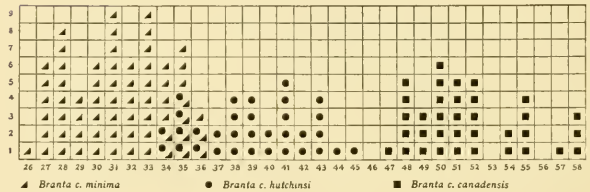

Fig. D.—Length of culmen of *B. c. canadensis*, *B. c. hutchinsi*, and *B. c. minima*. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at the bottom, length of culmen in millimeters.

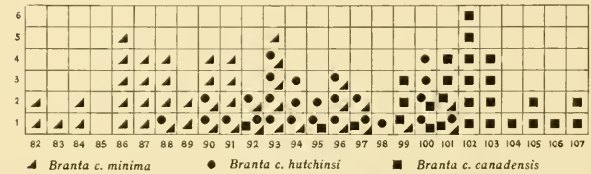

Fig. E.—Ratio per cent of middle-toe-and-claw to tarsus in *B. c. canadensis*, *B. c. hutchinsi*, and *B. c. minima*. Numerals at left of diagram indicate number of specimens; numerals at the bottom, ratio.

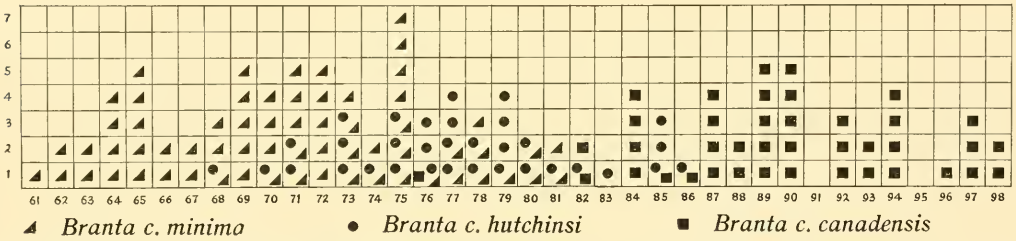

Fig. F.—Length of tarsus of *B. c. canadensis*, *B. c. hutchinsi*, and *B. c. minima*. Numerals at left of diagram indicate number of specimens; numerals at the bottom, length of tarsus in millimeters.

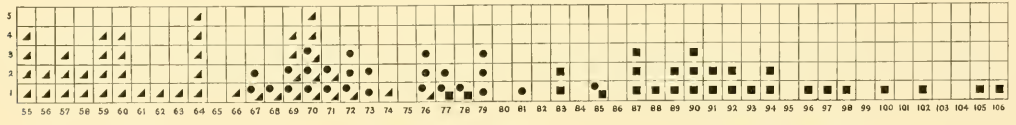

Fig. G.—Length of middle-toe-and-claw of *B. c. canadensis*, *B. c. hutchinsi*, and *B. c. minima*. Numerals at left of diagram indicate number of specimens; numerals at the bottom, length of middle-toe-and-claw in millimeters.

Fig. 11.—Length of wing of *B. c. canadensis*, *B. c. hutchinsi*, and *B. c. minima*. Numerals at the left of the diagram indicate number of specimens; numerals at the bottom, length of wing in millimeters.

SUMMARY

Briefly summarized, the following are the conclusions reached in the present paper:

(1) The geese of the *Branta canadensis* group are best regarded as one species, *Branta canadensis*, with four subspecies, *canadensis*, *occidentalis*, *hutchinsi*, and *minima;* this without attempting to go into the problems involved in the nomenclature of the races—the questions arising as to the proper application of the names *leucoparcia*, *hutchinsi*, *minima* and *occidentalis*—but accepting the usage adopted in the 1910 edition of the A. O. U. *Check-List*.

(2) The status of the group in California is as follows: The form found breeding in the state is *Branta c. canadensis;* the forms occurring in winter are *canadensis*, *hutchinsi*, and *minima*. Contrary to the statement repeated in practically all ornithological books dealing with the subject, *B. c. occidentalis* does not occur in California at any season.

(3) *Branta c. occidentalis* is a well-defined subspecies occupying the humid, northwest coast region, where it is practically resident, performing only the most limited migrations, or none at all.

(4) In differentiating the subspecies of *Branta canadensis* undue emphasis has heretofore been placed upon certain characters which are for the most part too variable to be depended upon. Thus the cause of the confusion which has existed relating to the true status of *B. c. occidentalis* is partly due to mistaken ideas as to which are the most nearly constant characters of the subspecies. A careful analysis of many of the contradictory statements on record in regard to the summer habitats of *B. c. hutchinsi* and *B. c. minima* makes it appear probable that this uncertainty also is largely due to misconceptions as to the real characters of these forms.

Transmitted February 6, 1913.

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PLATE 1

Ventral view of heads of *Branta canadensis minima,* illustrating variation in color patterns. The Museum numbers of the specimens shown, reading from left to right, are as follows: upper row, 22076, 22033, 22021, 22060, 22014, 22045, 22038; lower row, 22031, 22021, 22027, 22039, 22017, 22044, 22056.

The specimens in the upper row are arranged to show variation in the breadth of the white collar, ranging from the one at the extreme left, in which there is more white than black on the neck, through varying degrees to the specimen at the extreme right, in which the white collar is totally lacking.

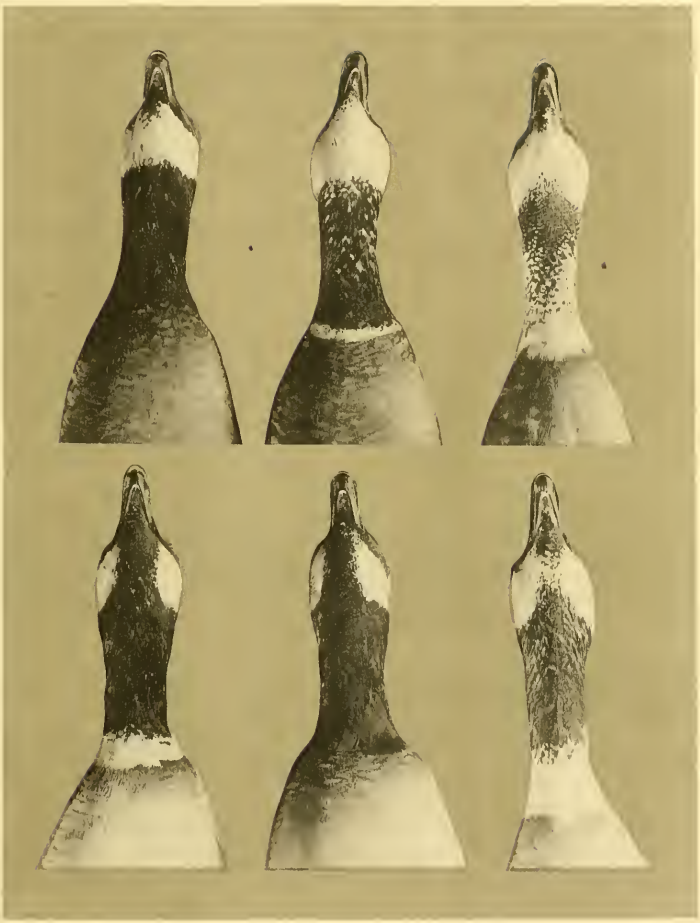
The lower row shows variation in the black throat bar, this mark being most highly developed in the specimen at the extreme left, and ranging through lessening degrees of extensiveness to total absence in the one at the extreme right.

As shown here there is no correlation between these two markings, each of them varying independently of the other. Another color character, the shade of the underparts (hardly apparent in a black and white illustration) also varies independently of either of these. The birds shown on the plate were all collected in their winter home.

PLATE 2

Ventral view of heads of *Branta canadensis minima*, illustrating variation in color patterns. The Museum numbers of the specimens shown, reading from left to right, are as follows: upper row, 22038, 22014, 22076; lower row, 22035, 22042, 22033.

Typical *minima* is supposed to be marked with a white collar at the base of the black neck, and with a black line on the throat dividing the white cheek patches, as shown in no. 22035. The specimens figured illustrate every possible combination of these markings, demonstrating the impossibility of properly diagnosing the subspecies on the basis of color or pattern.



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NOCTURNAL WANDERINGS OF THE CALIFORNIA POCKET GOPHER

BY
HAROLD C. BRYANT

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NOCTURNAL WANDERINGS OF THE CALIFORNIA POCKET GOPHER

BY
HAROLD C. BRYANT
(Contribution from the Museum of Vertebrate Zoology of the University of California)

An incident bearing on the life-history of the pocket gopher has been recently reported to the writer by Mr. J. E. Light of Berkeley, California. He found on the morning of May 1, 1913, more than fifty pocket gophers (*Thomomys bottae bottae*) stuck in a strip of oil about two feet wide which had been left along the side of a street in process of repair in North Berkeley. These facts have been fully verified by the writer. All of the gophers appeared to have been traveling in the same direction, namely, east, and had crossed a macadam road before reaching the oil. The sticky oil had rendered them helpless in a short time, and their struggles to escape resulted only in entrapping them the more firmly, thus hastening their death. Some had been torn to pieces by cats and dogs after being caught in the oil, and others had doubtless been carried away altogether by these predators. Ten of the gophers were collected the next day within a stretch of two hundred feet. Two of these were apparently adult males, the rest being females and half-grown young.

If this incident be taken as evidence, gophers come out of their burrows at night and travel above ground. Some mammals are known to travel about during the rutting season more than at other times. The time of year and the occurrence of large numbers of half-grown individuals, however, would seem to preclude the use of this fact in explanation of the phenomenon in this case. Bailey (1895, p. 16) in speaking of the pocket gopher states: "Apparently only the males

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leave the burrows in quest of mates, though positive information on the subject is difficult to obtain."

The only reference to a habit of foraging above ground that the writer has been able to find is the following from E. T. Seton (1909, p. 571): "Frequently, possibly every night, the gopher quits the burrow and sallies forth into the open air, foraging for grain and other foods not obtainable underground. These it crams into its pouches, then retires to its burrow to consume them. The cover of night is essential to these expeditions; they are seldom made in broad daylight, though they may be undertaken in twilight or by the light of the moon." The present writer has been told that in California different species of pocket gophers have been occasionally observed above ground at night.

Mr. Light in experimenting on methods of trapping in the same locality (North Berkeley) has found that gophers will follow ditches. By digging a small trench and sinking into the earth empty oil cans as pitfalls, a method also used in trapping moles, he has been successful in catching a number of pocket gophers. This is further evidence that gophers travel about on top of the ground at night to a greater extent than has hitherto been supposed.

This habit of quitting the burrow at night would also seem to be substantiated by the fact that barn owls capture large numbers of pocket gophers. One of these birds has been recorded as capturing as many as fifteen gophers in a single night. It hardly seems probable that so large a number could be obtained were not some of them picked up on top of the ground.

Unlike most of the strictly nocturnal rodents, the pocket gopher may often be seen feeding in the daytime, especially if the day be a cloudy one. A quivering plant, on the roots of which the gopher is feeding, or a momentary glimpse of a dark head disappearing down a hole, is usually the only evidence to be noted. It is very seldom, if ever, that a gopher is seen *outside* of his burrow during daylight, except when flooded out by irrigation. The writer's only experience in this regard was in a newly ploughed field, where he found a large gopher wandering about in one of the furrows. It had doubtless been ploughed out, or its burrow had been disturbed by the ploughing. In the endeavor to reach a food plant a gopher will sometimes go as much as six inches from the mouth of the burrow, but it will dart back in alarm at the slightest disturbance. In the late summer a circular area of a radius of about the distance from the rump to the nose of a

gopher can be found picked clean around the mouth of the burrow, showing that the food-getting has been limited largely to this circumscribed area.

Another thing which it seems difficult to explain in connection with the incident first noted is the fact that if gophers do travel about at night they are certainly successful in finding their burrows again or in digging new ones before daylight appears. Their digging ability would seem to be sufficiently effective to afford them plenty of chance to conceal themselves again. Still, it is the common belief of observers that each one of the complex systems of tunnels constitutes the permanent home of an individual gopher.

If it be true that pocket gophers forage regularly above ground, we have a partial explanation of how it became possible for gophers to be entrapped in the oil. But why there should have been so many on one particular night, or why they were apparently all traveling in the same direction, remains unexplained. Such a migration seems the more remarkable in that pocket gophers are supposed to lead a solitary life. Bailey (*loc. cit.*) states that from the time the young are half grown and big enough to start burrows of their own each individual lives entirely alone, except during the short mating season in early spring. If each of the gophers caught in the oil had been living by itself, it seems remarkable that so many should have come out of their burrows on the same night and should have moved in the same direction.

The data at hand will not allow of the conclusion that this migration, if it can be called such, is exactly comparable with the sporadic migrations of lemmings, or of meadow mice. It is certain, however, that from some unknown cause large numbers of gophers left their burrows on the night of May 1, 1913, in North Berkeley. That they were either engaged in foraging or were seeking to improve their food supply, when entrapped in the oil, seems probable.

The accompanying photograph (fig. 1) shows four half-grown pocket gophers, as seen by the writer on June 1, 1913, caught in oil which had seeped down into the gutter in the same locality where Mr. Light's observations were made. One was still breathing when found. A meadow mouse (*Microtus californicus*) and three other gophers were similarly entrapped a few yards away the same night.

The above incident further suggests crude oil as a possible method of getting rid of gophers. If so many gophers were entrapped in a strip of oil two feet wide in Berkeley, why would not a strip the same

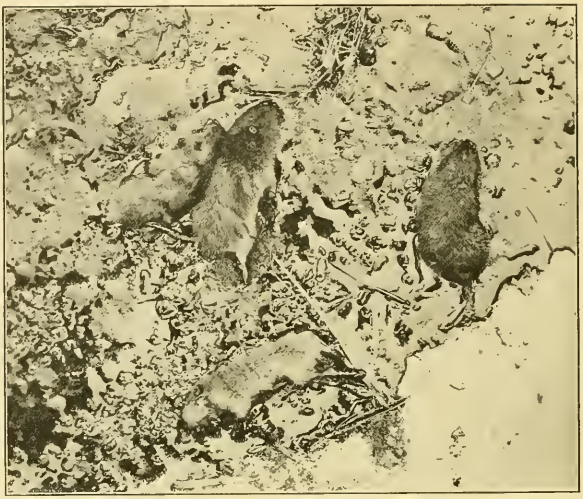

Figure 1

Photograph of four pocket gophers (*Thomomys bottae bottae*) as found entrapped in crude oil which had seeped into the gutter from a newly made street in North Berkeley, California. One gopher was still breathing when discovered. Although firm earth extended within six inches of the animal, escape from the sticky oil had proven impossible.

width prevent gophers from migrating into an orange orchard? And carrying the idea still farther, if a gopher may be entrapped in oil on top of the ground, why may it not be entrapped in the same substance if it is placed in the burrow? The experiment should be tried. It might prove effectual in an attempt to rid new land of these pests, even if it does not prove practicable on a small scale.

One fact, at least, would appear to minimize the value of oil for this purpose. Two days after application the surface of the oil hardens and small animals are able to cross without danger. On the other hand, its cheapness helps to balance this disadvantage. A thing to be further considered is the undesirable effect of crude oil on the soil.

The effectiveness of crude oil, or asphaltum, as a trap for animals is demonstrated by the recent findings of great masses of vertebrate

remains in the asphalt beds of Rancho La Brea, near Los Angeles, California. In these remarkable beds the bones of numerous prehistoric as well as present-day animals, including rodents, are found accumulated in masses from twenty to thirty feet deep (see Merriam, 1911, pp. 199–213).

Transmitted September 5, 1913.

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BY

SARAH ROGERS ATSATT

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THE REPTILES OF THE SAN JACINTO AREA OF SOUTHERN CALIFORNIA

BY

SARAH ROGERS ATSATT

INTRODUCTION

During the summer of 1908 a collection of reptiles of the San Jacinto area was made by two parties sent out from the Museum of Vertebrate Zoology of the University of California. The material thus obtained, together with the field records of Messrs. Grinnell, Swarth, Taylor, Richardson, and Camp, has constituted the major portion of the basis of this report. Several specimens collected by Mr. Bridwell in July, 1912, are also in the Museum collection. In July, 1912, the writer spent two weeks collecting in the San Gorgonio Pass and on the Pacific side of the mountain as far south as Strawberry Valley. The fresh material obtained then has been of use in determining coloration, inasmuch as the material of 1908, preserved in both alcohol and formalin, is discolored in some cases.

A full account of the localities is given in a report on the birds and mammals of the San Jacinto area in a preceding paper (Grinnell and Swarth, 1913). In brief the regions in which collecting was carried on are as follows: Whitewater, Snow Creek, Cabezon and Banning are in the San Gorgonio Pass, which extends nearly east and west from the desert toward the coastal valley, from Lower Sonoran to dilute Upper Sonoran at Banning. Directly south of Cabezon the "Hall Grade" ascends the ridge to Hurley Flat in the Upper Sonoran zone; above Banning is Poppet Flat, also Upper Sonoran. Higher on the mountain at about 5000 feet is Schain's Ranch on the border line between Upper Sonoran and Transition.

Still higher and to the southeast is the region designated as Fuller's Mill in true Transition country. A well-marked valley, Strawberry Valley, of low Transition character, is south of Fuller's Mill and southeast of and heading up towards San Jacinto Peak. Tahquitz Valley, high up in the Transition zone, is directly south of the Peak. Southeast of the Peak is Round Valley, which marked the upper limit of observed reptiles. Kenworthy and Hemet Lake are near the head of the south fork of the San Jacinto River, south of the San Jacinto Peak and northwest of the Santa Rosa region. They are Upper Sonoran with occasional Transition "islands." West of them is Thomas Mountain. Eastward and on the desert side of the range are Piñon Flat and Asbestos Spring in Upper Sonoran. A little farther east is the extreme limit of the San Jacinto mountains, where Dos Palmos Spring, with Carrizo Creek flowing from it to the desert, and the neighboring parallel cañon, Deep Cañon, show the Lower Sonoran and desert aspects. From the ridge between Kenworthy and Dos Palmos heads Palm Cañon, leading almost directly north and emptying out upon the desert around the corner from Whitewater. It is Lower Sonoran. South of Piñon Flat are the localities higher in the Santa Rosa region, namely, Garnet Queen Mine, Santa Rosa Mountain and Toro Peak. The two latter are in high Transition. On the western side from Hemet Lake the San Jacinto River road leads to Vallevista, an "island" of Lower Sonoran. In 1912 the road from the town of San Jacinto to Beaumont, east of Banning, was covered also. After encircling the base of the hills for a few miles the road leads through Lamb Cañon, passing from the hills covered with dead grass into thick chaparral at the head of the cañon (2500 feet).

The reptilian population of the San Jacinto area varies in abundance of species and individuals according to locality. The number of specimens recorded cannot indicate exactly the relative abundance because of the inequalities of collecting, both in time and weather conditions. Yet a general impression of population results which probably approximates the correct relative abundance.

Material collected in 1908, or in 1912 by Mr. Bridwell, is quoted under Museum of Vertebrate Zoology numbers; that collected in 1912 by myself is indicated by numbers bearing an asterisk.

To Professor Charles A. Kofoid, under whose direction the work has been done, and to Mr. Joseph Grinnell of the Museum of Vertebrate Zoology, the writer desires to express her indebtedness for their most valuable suggestions and criticism.

DISCUSSION OF SPECIES

Callisaurus ventralis (Hallowell)

Gridiron-tailed Lizard

Distribution: Recorded as follows: Vallevista, 1800 feet, nos. 502–3; Cabezon, 1700 feet, nos. 176, 187; Whitewater, 1130 feet, no. 147, nos. *27–32; Dos Palmos Spring, 3000–3500 feet, nos. 242, 238–9, 476–7, 479–482, 484, 561–2; Piñon Flat, 4000 feet, nos. 478, 483; Deep Cañon, 3000 feet, no. 241; Palm Cañon, 2500 feet, no. 240.

The gridiron-tailed lizard is generally a Lower Sonoran form, but on the desert side of the Santa Rosa mountains it ranges up into the Upper Sonoran area on Piñon Flat. Here, however, the piñon belt occurs on a ridge between two Lower Sonoran areas. The species was most common in Whitewater, Deep Cañon and Dos Palmos, that is, in regions having access to the true desert. Van Denburgh (1897, p. 50) cites the occurrence of this form near Banning, although it was not found there either in 1908 or 1912. With the addition of the sandy wash of Vallevista as a new station to the previous records of Cajon Pass, San Bernardino County, and Oak Springs, San Diego County, three places are known where this lizard occurs west of the mountain range. In none of these places does the lizard seem to be abundant. From Oak Springs eight have been recorded, from Cajon Pass two, while at Vallevista not over half a dozen were seen. In all cases a fairly direct connection with the desert is possible, but these stations are now isolated. These western examples are identical with the eastern desert form.

At Dos Palmos at half past six in the morning several of these lizards were kicked out of the sand of the trail by the horses' hoofs. At Whitewater in 1912 an interesting color change was noted in an individual which was very light on the white sand but on coming under the shade of a scraggly bush developed a gray pattern.

Crotaphytus collaris baileyi Stejneger

Bailey Lizard

Distribution: Snow Creek, 1500–2000 feet, nos. 210–1; "Hall Grade," 2000 feet, no. 1; Palm Cañon, 800 feet, nos. 231, 243.

This species is generally Upper Sonoran or in the *Grayia* belt of Lower Sonoran. In the San Jacinto area it is on the lower edge of Upper Sonoran and in Palm Cañon is found in Lower Sonoran.

The lizards were found inhabiting both rocky and sandy spots.

Crotaphytus wislizenii Baird and Girard

Leopard Lizard

Distribution: Vallevista, 1800 feet, no. 496; Cabezon, 1700 feet, nos. 174–5, no. *6; Snow Creek, 1500 feet, no. 153; Dos Palmos Spring, 3000 feet, no. 232. On Piñon Flat several were noted.

This species usually occurs in Lower Sonoran and arid Upper Sonoran. In the San Jacinto area it is found in Lower Sonoran and on the edge of Upper Sonoran.

These lizards were found on the ground in the brush. Several were observed to be swift runners.

Sauromelas ater Dumeril

Chuck-a-walla

Two typical individuals of large size were taken. At an altitude of 3500 feet near Dos Palmos Spring no. 560 was shot as it was sitting on the topmost ledge of a boulder pile. Several others were seen at a distance, usually with only their heads in sight. In their habits they were shy.

At Snow Creek, 1500 feet, the other, no. 193, was found alive, caught in a trap in the morning. It offered to bite when approached and puffed up its body until its skin was taut.

Uta mearnsi Stejneger

Mearns Lizard

Distribution: Banning, 2200 feet, nos. 87, 121–3, 149, 190; Cabezon, 1700–2000 feet, nos. 4, 137, 178–9, 200, no. *11; Dos Palmos Spring, 3500 feet, no. 571; Palm Cañon, 3000 feet, no. 234; Lower Palm Cañon, 800 feet, nos. 235–6.

Previous records of this species are all from the eastern slope of the Coast Range of San Diego County near the Mexican boundary line. In the San Jacinto region it is found rather generally in the Lower Sonoran and dilute Upper Sonoran areas on the desert (eastern) side of the range and through San Gorgonio Pass. In coloration the most noticeable feature is the generally darker and more uniform appearance of our specimens as compared with those from the San Diego Range.

Throughout all their range these lizards are dwellers on the rocks, usually on the vertical sides. At Palm Cañon they are noted as being shy, darting about with great rapidity, scarcely trusting themselves

in an exposed spot. They remained out of sight during the day, seemingly to avoid the direct hot sunlight, coming out after the sun was below the western wall of the cañon and while the air and rocks were still hot. At Cabezon on the "Hall Grade" many were seen which were rather easy of approach.

Uta stansburiana Baird and Girard

Brown-shouldered Lizard

Distribution: The wide distribution and full representation of this species is shown in the following record: Vallevista, 1800 feet, no. 505; Snow Creek, 1500–2000 feet, nos. 88–92, 150, 192, 218–9; nos. *13, 19–23; Cabezon, 1700–2000 feet, nos. 15–6, 169–70, 208, no. *8; Schain's Ranch, 5000 feet, nos. 332–4, 338–40, 355–62, 366–7, nos. *35–7; Fuller's Mill, 5900 feet, no. 310, no. *41; Strawberry Valley, 6000 feet, nos. 525, 3802; Kenworthy, 4500 feet, no. 578; Dos Palmos Spring, 3500 feet, no. 368; Palm Cañon, 3000 feet, no. 252. It was noted frequently from Banning to Strawberry Valley and from there towards Hemet; it also occurred in Deep Cañon.

This form was especially abundant at "Hall Grade," Snow Creek, Banning, Schain's Ranch, and Dos Palmos Spring. On the road between Schain's and Fuller's Mill in one morning about three dozen were observed in sunny places below the pine belt. The area of greatest population was between 4000 and 5000 feet. This species occurs in Upper and Lower Sonoran zones and in small numbers in the Transition zone.

The individuals present a wide range of variation in color and pattern which corresponds to Van Denburgh's description (1897, p. 67).

Sceloporus biseriatus Hallowell

Fence Lizard

Distribution: This common species was collected as follows: Vallevista, 1700 feet, no. 506; Cabezon, 1700–2000 feet, nos. 13–4, 134–6, 152, 201–5, no. *10; Banning, 2200 feet, nos. 93–4, 99, 116–20; Schain's Ranch, 4000–5100 feet, nos. 290–4, 328–31, 337, 351–2, 363–5; Fuller's Mill, 5300 feet, nos. 100–1, no. *42; Strawberry Valley, 6000 feet, nos. 6–9, 520–1, 559, 585, 590–1; Hemet Lake, 4400 feet, nos. 492, 494, 509–11; Kenworthy, 4500 feet, nos. 564–5; Thomas Mt., 6800 feet, nos. 493, 512–3; Garnet Queen Mine, 6000 feet, nos. 522–3;

two were seen near Relief Hot Springs, 1500 feet, on the road from Hemet to Beaumont.

Apparently the only regions where this species was not present are the highest peaks of the area and the desert region of the Santa Rosa mountains. At 5900 feet and above on the road from Schain's to Fuller's Mill this form seems to be displaced by *Sceloporus graciosus*.

At Cabezon on May 7, 1908, a female (no. 202) was taken which contained an egg, yellow in color and irregularly ovate in shape. A large proportion of the specimens were found on rocks, but some were on trees or stumps in such higher localities as Schain's and Strawberry Valley.

Sceloporus graciosus Baird and Girard
Mountain Lizard

Distribution: Above Schain's Ranch, 5300 feet, nos. 296, 301, nos. *39, 40, 43; Fuller's Mill, 5850–7000 feet, nos. 103, 297–309; Strawberry Valley, 6000 feet, no. 592; Tahquitz Valley, 8000 feet, no. 495; cañon east of Round Valley, 8500 feet, no. 526; Thomas Mt., 6800 feet, nos. 514–5; Santa Rosa Peak, 7500 feet, nos. 527–533.

The range of this lizard is in the Transition zone; but it begins at the very lowest margin and also reaches the upper limit of this zone, as for instance in the neighborhood of Hidden Lake, east of Round Valley. Along Fuller's Mill ridge this species replaces *Sceloporus biseriatus* as the altitude increases, until *Sceloporus graciosus* reaches its maximum of population between 5800 and 6000 feet. In the Transition zone over the higher parts of the Santa Rosa region from the peak to Toro this was the only reptile observed. Here it was abundant everywhere, about logs as well as rock piles.

The coloration of these San Jacinto specimens is much grayer in tone than in those from Nevada and the Sierra Nevada, which are brownish. It is also very much darker than that specimen figured (as *S. gracilis*) by Girard (1858, pl. xx, fig. 1). The amount of blotching in even the most pronounced case is less than in the type and from this a series can be made with gradual decrease of blotching and lightness of longitudinal lines until there is little pattern visible.

The adult lizards are found on rocks, pine or cedar trunks or stumps. The juvenals were found more often in the shade in dead grass. Around Fuller's Mill they were not shy and were reported as even allowing themselves to be taken with the hand. At Santa Rosa

Peak, however, they were too lively to be noosed. The ones observed in the valley by Hidden Lake were surprisingly wild, even on a cold gray morning darting immediately under the rocks.

Sceloporus magister Hallowell

Rough-scaled Lizard

Distribution: At Cabezon, 1700 feet, two adult males, nos. 180, 188, were taken; at Dos Palmos Spring, 3000 feet, one adult and one juvenal, nos. 488, 490, were secured. One individual was seen at Snow Creek.

In general coloration these forms are more grayish than material from other localities. The juvenal color is of a light yellowish anteriorly and bluish posteriorly.

This species is a typical desert form and is found under yucca or cactus plants.

Sceloporus orcutti Stejneger

Dusky Scaled Lizard

Distribution: Snow Creek, 1500–2000 feet, nos. 80–3, 160–4, nos. *14–7, 24–6; Cabezon, 1700–2000 feet, nos. 8–11, 127–30, 171, 206, nos. *5, 9; Banning, 2200 feet, nos. 12, 113–5, 165, 189; Poppet Flat, 4100 feet, no. 325; Schain's Ranch, 4800–5100 feet, nos. 289, 324; Fuller's Mill, 5900 feet, no. 288; Lamb Cañon, 2500 feet, no. *45; Hemet Lake, 4400 feet, no. 508; Dos Palmos Spring, 3000–3500 feet, nos. 251, 489, 570; Kenworthy, 4500 feet, nos. 566–9.

Sceloporus orcutti is found in Lower and Upper Sonoran and in the Transition zones, but its center of population seems to be in Upper Sonoran. It migrates into the upper edge of Lower Sonoran and appears in Transition on the Fuller's Mill ridge. It is associated with the Sonoran chaparral characterized by sagebrush, manzanita, and scrub-oak.

In the scalation of *Sceloporus orcutti* one notices that the caudal scales are strongly keeled, although Van Denburgh (1897, p. 87) calls them nearly smooth. Strong keels were found in all the specimens of *S. orcutti* in the Museum. The dorsal scales are described as varying from no keels to very obtuse ones, with points scarcely protruding beyond the scale. The *S. orcutti* of the San Jacinto region all show obtuse keeling of the dorsals. In several the tendency to sharper keeling and longer points is very noticeable.

The most characteristic lizard of the San Jacinto region and the one most noticeably missed as one crosses the San Gorgonio Pass and enters the San Bernardino region is *Sceloporus orcutti*. The grotesque large black males with their bull-dog-like pose, the gaudily colored males of medium size, the paler cross-barred females and juvenals are inseparably associated with the foot-hills and lower areas of San Jacinto. Their wildness or shyness seems to vary with localities. Generally in the late afternoon the males are very bold and will calmly await approach within a few feet.

Phrynosoma blainvillei blainvillei Gray

Blainville Horned Lizard

Distribution: Vallevista, 1800 feet, no. 498; Cabezon, 1700–2000 feet, nos. 146, 167, 184–6, 277; Banning, 2200 feet, nos. 76–7, 102, 212, 348; Poppet Flat, 2800–4300 feet, nos. 345–7; Schain's Ranch, 4900 feet, nos. 272–5, 322–4, 336; Fuller's Mill, 5900 feet, no. 276; Kenworthy, 4500 feet, nos. 573–5; Vandeventer Flat, 4500 feet, nos. 576–7; Oak Spring, 4900 feet, no. 233.

These forms as determined by Mr. Bryant are all typical *P. b. blainvillei*. Whereas they show well the color of the ground on which they lived, they show no variation as to altitude or slope of the mountain. For typical measurements see Bryant (1911, p. 37).

This species occurs in Lower and Upper Sonoran and low Transition zones, but the bulk of the population is in Upper Sonoran.

Phrynosoma platyrhinos Girard

Desert Horned Lizard

At Whitewater, 1130 feet, a small specimen, no. * 33, was taken in 1912. It was on the white sand, not far from several individuals of *Callisaurus ventralis*. In coloration it is a light gray above, marked with greenish gray spots. On either side of the neck the dark spots show plainly. Ventrally it is pure white except for a few black flecks in the post-anal region, on one leg, and on the tip of the tail.

Gerrhonotus scincicauda ignavus Van Denburgh

San Diegan Alligator Lizard

Distribution: Vallevista, 1800 feet, nos. 500–1; Babezon, 1700 feet, nos. 133, 181–3; Schain's Ranch, 4900 feet, nos. 269, 319–21; 335; Strawberry Valley, 6000 feet, nos. 557–8; Kenworthy, 4500 feet, no. 224; Garnet Queen Mine, 6000 feet, no. 524.

All are typical, having keeled temporal, arm, and forearm scales and keeled ridges in the fifth or sixth scale from the mid-ventral row behind the anus.

In characteristics observed these lizards were like the rest of the genus. They are fond of shelter, such as thick ferns along the bottom of a gulch, in a grapevine under a cottonwood tree, in oak brush, under a lilac bush, or in a rose tangle. Although usually slow of movement when under no fear, after they are captured they will fight, biting a stick and even themselves. Occasionally they climb into bushes in efforts to escape pursuit.

Cnemidophorus stejnegeri Van Denburgh

Stejneger Whip-tailed Lizard

Distribution: Snow Creek, 1500 feet, nos. 84–6, 154, 156–9, 213–6, no. *18; Cabezon, 1700–2000 feet, nos. 5, 6, 131–2, 148, 168, 172–3, 191, 198, nos. *1–4, 7, 12; Banning, 2200 feet, nos. 7, 95–6, 155; Poppet Flat, 3700–4500 feet, nos. 268, 349–50, nos. *34, 38; Hemet Lake, 4400 feet, no. 516; Vallevista, 1800 feet, no. 497; Asbestos Spring, 3500 feet, no. 247; Dos Palmos Spring, 3500 feet, nos. 230, 246, 369, 485–7; Palm Cañon, 800 feet, no. 245. At Deep Cañon a few individuals were noted. This species ranges in Upper and Lower Sonoran.

One of the distinctions between *C. tigris* and *C. stejnegeri* is based on scalation, on the relative size of dorsal granules and the relative size of central gular and collar scales. Since these appear to vary with age, comparison has to be made on specimens accurately agreeing in size, as there is no structural criterion of age or relative development. Under such circumstances within any given group of material of either species one finds variation in relative proportions—such wide variations as to make the specific determination extremely difficult. The other distinction is based on the gray suffusion and the clearness of pattern on sides of head, neck, and gular region. *C. tigris* from Nevada in the Museum collection presents both distinct and indistinct markings on the sides of the head, while the specimens from Mecca, California, have distinct markings and those from Colorado River have generally indistinct markings. *C. stejnegeri* from the Pacific slope has almost no gray suffusion, but specimens from regions bordering on the desert show some gray suffusion. No. *18 taken at Whitewater in 1912 has the flatter and smaller gular scales characteristic of *C. tigris*, but it has also the slight gray suffusion, distinct black markings on the sides of the head, and very evident cross-band

gular spots of *C. stejnegeri*. A general survey of material of both groups raises the question of possible intergradation. A study of the habits and reaction to environment of each of these species ought to be carried out before the question can be satisfactorily settled. In a general survey of masses of material one feels that the effect of the environment upon the individual has been great.

This species is a ground-loving form. At Cabezon it was noted frequently on the mesa among the cactus; at Snow Creek amid the leaves under the cottonwoods or among the rocks. It seems to be able to run through grass no matter how close set. At Banning and Dos Palmos Spring several were caught during the day in unbaited mouse traps in the sandy wash or in the brush. At Cabezon several were caught in traps baited with oatmeal. The same was true in previous collecting at Mecca, California, of lizards of this genus. Since unbaited traps, as well as baited ones, seem to be effective, it is most probable that the lizards were not eating oatmeal. Perhaps the odor of the dried blood or flesh of animals previously caught in those traps attracts either the lizards or the insects upon which the lizards feed, or perhaps the novelty of the trap in the neighborhood attracts the lizards. In escaping pursuit at Cabezon these lizards ran along the ground and burrowed in the soft sand or crawled under cactus. At Snow Creek they took refuge between or under the many rocks without running along on the ground for any distance.

Verticaria hyperythra beldingi Stejneger
Belding Orange-throat Lizard

At Vallevista, 1800 feet, in a stubble field was taken no. 504. It is small in size, 9.6 mm. in length, of which 6.6 mm. is tail. The tail has the characteristic blue color of juvenals. On the outskirts of the town of San Jacinto on the road to Beaumont, 1500 feet, no. *44 was found rustling among dead cottonwood leaves. Another was seen but not captured.

At Reche Cañon, near Colton, during the summer of 1908 several were collected in such habitats as a sandy wash, on a hill sparsely covered with vegetation, and in the dust by the roadside. Record was made of two found in the act of copulation on July 22.

Eumeces skiltonianus (Baird and Girard)
Western Skink

One specimen of this species, no. 295, was secured several miles above Schain's Ranch, 5300 feet. It is small, probably a juvenal,

with one-third of its tail regenerated. As is characteristic, it was rustling among dry leaves in a shady place. Another specimen, no. 3803, was taken at Strawberry Valley, 5500 feet, in 1912.

Lichanura roseofusca Cope

California Boa

Distribution: Cabezon, 1700 feet, no. 207; Palm Cañon, 3000 feet, no. 223. Both specimens are deep drab and no. 223 shows three reddish longitudinal bands.

So far as observed in this region this snake is an inhabitant of the Lower Sonoran zone only.

No. 207 was found trying to swallow one of the large *Peromyscus* which had been caught in mouse traps. It had wrapped its body about the mammal whose head it had taken into its mouth. When disturbed it crawled slowly away and upon being gently struck on the head, coiled up in a ball, completely obscuring its head.

Diadophis amabilis Baird and Girard

Western Ring-necked Snake

A specimen of this snake, no. 3801, was collected at Strawberry Valley, 5500 feet, in July, 1912. It was crossing the road when captured, in the afternoon.

Lampropeltis boylei Baird and Girard

Boyle Milk Snake

Distribution: Cabezon, 1700 feet, no. 143; Banning, 2200 feet, nos. 97, 221; Hemet Lake, 4400 feet, no. 507; and in 1912 seen at Cabezon and on the "Hall Grade."

The dorsal scales are arranged in longitudinal rows numbering as follows for the whole length between the head and anus: nos. 97, 221, 507 all have 23–21–19; no. 173 has 23–21.

This snake is associated with the chaparral of Lower and Upper Sonoran.

Lampropeltis pyrrhomelaena multicincta (Yarrow)

Coral King Snake

Distribution: Strawberry Valley, 6000 feet, no. 729. In this specimen the black rings are frequently more or less joined on the mid-dorsal area. The snout, labials, and two-thirds of the parietals

are black, the cross-bar of black touches the parietals, the yellow cross-bars number thirty-six. The dorsal scale rows are 21–19–17.

This species is limited to the Transition zone.

Rhinocheilus lecontei Baird and Girard
Long-nosed Snake

Distribution: Cabezon, 1700 feet, no. 144; Dos Palmos Spring, 3500 feet, no. 228.

No. 144 is typical in the red coloration with much black and white spotting. It has 207 gastrosteges and 36 single urosteges followed by 2 sets of alternately divided and single and by 13 divided ones. Dorsal scale rows are 23–21–19. No. 228 is large in size and of dark brown and white coloration with no red and no markings on the sides between the brown patches. It has 214 gastrosteges and 42 urosteges followed by 10 double ones. Dorsal scale rows are 25–23–21–19.

This species seems to be restricted to Lower Sonoran.

Hypsiglena ochrorhynchus Cope
Spotted Night Snake

While this form was not found in 1908 or 1912, it is reported (Van Denburgh, 1897, p. 180) from Strawberry Valley, 5000 feet, and from San Jacinto.

Salvadora grahamiae Baird and Girard
Patched-nosed Snake

Distribution: Banning, 2200 feet, no. 145. This specimen is rather dark with broad dark bands. Dorsal scale rows are 17–15–13.

From previous records this species seems associated with arid areas in Lower and possibly Upper Sonoran zones.

Bascanion flagellum frenatum Stejneger
Red Racer

Distribution: Cabezon, 1700 feet, nos. 2, 3; Palm Cañon, 800 feet, no. 237. Another was also seen at Cabezon and another seen with no. 237 near the stream which comes from Murray Cañon into Palm Cañon.

Dorsal scale rows of nos. 2, 3 are 17–15–13–12 and in the case of no. 237, 17–15–13–12–11.

The red racer is a desert snake.

Bascanion laterale (Hallowell)

California Racer

Distribution: Cabezon, 1800 feet, no. 166; Banning, 2200 feet, no. 220; Schain's Ranch, 4900 feet, nos. 315, 316; Strawberry Valley, 6000 feet, no. 554; Kenworthy, 4500 feet, nos. 227, 572.

Dorsal scale rows number 17–16–15–14–13.

This species ranges in Lower and Upper Sonoran and possibly a little in low Transition. It is west of the desert region in which *B. f. frenatum* occurs.

No. 315 was captured in a grassy meadow; no. 316 was caught in a mouse trap.

Arizona elegans Kennicott

Faded Snake

None was taken in 1908 or 1912, but it is previously recorded at San Jacinto by Van Denburgh (1897, p. 194).

Pituophis catenifer (Blainville)

Western Gopher Snake

Distribution: Schain's Ranch, 4900 feet, nos. 104, 343; Strawberry Valley, 5500–6300 feet, nos. 551–3. Two small individuals were also seen in 1912 on the road from Schain's Ranch to Strawberry Valley and on the road from Strawberry Valley to Hemet.

The specimens are all typical with four prefrontals. Dorsal scale rows are 29–31 to 23.

As collected in the San Jacinto area this species is limited to Upper Sonoran and Transition, but from other records it is shown to occur in Lower Sonoran.

Thamnophis hammondi (Kennicott)

California Garter Snake

Distribution: Cabezon, 1700 feet, no. 138; Tahquitz Valley, 8000 feet, no. 555; Kenworthy, 4500 feet, no. 226; Palm Cañon, 800 feet, no. 244.

Dorsal scales rows are as follows: 21–19–17.

These localities show this species extending from Lower Sonoran to high Transition.

Crotalus lucifer Baird and Girard

Pacific Rattlesnake

Distribution: Banning, 2200 feet, nos. 112, 126; Schain's Ranch, 4900 feet, nos. 270–1, 317–8, 342 (heads only of 270–1, 318); Strawberry Valley, 6000 feet, nos. 518, 556, 580; Tahquitz Valley, 8000 feet, no. 579; Santa Rosa Peak, 7000 feet, no. 517; Thomas Mt., 6800 feet, no. 581; Vallevista, 1800 feet, no. 519.

The length of no. 579, including the rattles, was forty-five inches.

This species ranges in both Sonoran zones and throughout the Transition. The alimentary tract of no. 579 contained four undigested half-grown ground squirrels. No. 318 contained an adult *Neotoma*.

Crotalus cerastes Hallowell

Sidewinder

While none was taken or seen, at Whitewater in 1912 reliable information was given that sidewinders were frequent in that region.

Crotalus mitchelli Cope

Bleached Rattlesnake

Distribution: Poppet Flat, 3300 feet, no. 341; Asbestos Spring, 4500 feet, no. 222. The length of no. 222 was given as thirty-five inches and the girth as five inches.

In the San Jacinto region this species was found on the lower limits of Upper Sonoran. In its general range, however, it is associated with desert conditions.

Crotalus ruber (Cope)

Red Rattlesnake

Distribution: Cabezon, 1700 feet, no. 139; Dos Palmos Spring, 3500 feet, nos. 225, 582–3. Reports were received in 1912 of red rattlers being killed at Cabezon and Hurley Flat above Cabezon.

No. 225 measured forty-three inches without the rattles.

This species apparently inhabits the Lower Sonoran zone and the lower margin of Upper Sonoran.

No. 582 was reported as being extremely active when found at daylight in the morning of August 23, 1908, at Dos Palmos Spring. Evidently it was not chilled by the night temperature. Another very active and demonstrative rattler was seen, but it retreated into a cleft in the rocks, from which it could not be dislodged.

CONCLUSIONS

In the study of this collection of reptiles from the San Jacinto area I find a fairly definite relation of their distribution to life zones. In the Transition zone, which is the highest one in which reptiles were found, both the species and individuals are few in number. The Transition zone in general runs along the tops of the ridges, being superseded by the Boreal only on the highest peaks. Parts of the Transition are isolated from each other and still more so from the Transition areas of other mountains of southern California. However, the two species *Sceloporus graciosus* and *Lampropeltis pyrrhomelaena multicincta*, which are characteristic of the Transition zone only, are found also in the Transition area of the San Bernardino mountains about twenty miles to the north across a depression of 5000 feet between the two zones.

The Sonoran zones, both Upper and Lower, encircle this area. On the northeastern and eastern sides of San Jacinto Peak the Upper Sonoran is very restricted in area because of the great steepness of the ridges, but on the western and the southern sides it spreads out to the coastal valley and the Santa Rosa mountains. It really forms the bulk of the actual area covered in collecting and it may be because of that reason that the number of individuals seems largest in Upper Sonoran. The Lower Sonoran occurs mainly pushing in from the desert through the cañons on the eastern side and running up through San Gorgonio Pass, but appears also in "islands" on the western base of the San Jacinto area. In the Lower Sonoran we find the greatest representation of species and a large number of individuals.

The relative distribution in these zones is detailed in Table I. Where gaps resulting from insufficient representation in the collection have occurred I have filled in with the distribution as recorded in the entire range of the various species by other writers, principally Van Denburgh (1897). Species occurring occasionally, but probably not in any considerable numbers, are placed in parentheses.

There are two marked faunas in the San Jacinto area, one in extremely arid country, known as the Colorado desert fauna, and the other in a semi-humid region, known as a part of the Pacific coast fauna, namely, the San Diegan fauna. While, roughly speaking, one of the faunas lies to the east and north of, and the other to the west and south of the main ridge of peaks, there are certain localities,

TABLE I

Lower Sonoran	*Upper Sonoran*	*Transition*
Sauromelas ater		
Sceloporus magister		
Phrynosoma platyrhinos		
Verticaria hyperythra beldingi		
Lichanura roseofusca		
Rhinocheilus lecontei		
Bascanion flagellum frenatum		
Crotalus cerastes		
Callisaurus ventralis	(Callisaurus ventralis)	
Crotaphytus wislizenii	(Crotaphytus wislizenii)	
Uta mearnsi	(Uta mearnsi)	
Crotalus mitchelli	(Crotalus mitchelli)	
Crotalus ruber	(Crotalus ruber)	
Cnemidophorus stejnegeri	Cnemidophorus stejnegeri	
Lampropeltis boylei	Lampropeltis boylei	
Salvadora grahamiae	Salvadora grahamiae	
(Crotaphytus collaris baileyi)	Crotaphytus collaris baileyi	
(Sceloporus orcutti)	Sceloporus orcutti	(Sceloporus orcutti)
(Bascanion laterale)	Bascanion laterale	(Bascanion laterale)
Phrynosoma blainvillei blainvillei	Phrynosoma blainvillei blainvillei	(Phrynosoma blainvillei blainvillei)
Uta stansburiana	Uta stansburiana	(Uta stansburiana)
Sceloporus biseriatus	Sceloporus biseriatus	Sceloporus biseriatus
Gerrhonotus scincicauda ignavus	Gerrhonotus scincicauda ignavus	Gerrhonotus scincicauda ignavus
Pituophis catenifer	Pituophis catenifer	Pituophis catenifer
Thamnophis hammondi	Thamnophis hammondi	Thamnophis hammondi
Crotalus lucifer	Crotalus lucifer	Crotalus lucifer
	Diadophis amabilis	Diadophis amabilis
	Eumeces skiltonianus	Eumeces skiltonianus
		Sceloporus graciosus
		Lampropeltis pyrrhomelaena multicincta

especially through the San Gorgonio Pass and at the opposite end of the area around Dos Palmos, where the two come together. The interrelations of these faunas in the cases of birds and mammals and some of the laws governing behavior of races on the margins of two faunas have been discussed in a preceding paper by Grinnell and Swarth (1913).

In a tabulation of the reptiles of the San Jacinto area in regard to faunal distribution I find somewhat the same groups. (1) Some species occur in both faunas, (2) some occur in one or the other fauna only, and (3) some occur mainly in one fauna but invade the other faunal area. In this third group the species invading one fauna from the other fall into two sections. In one section (*a*) the species invade the other faunal area for a short distance only, extending about to Cabezon from either end of the San Gorgonio Pass. The other section (*b*) contains species which invade for longer distances and at both ends of the area, passing from either direction through the entire length of San Gorgonio Pass and also pushing in from either direction in the region around Dos Palmos. The larger part of the invasion in this third group occurs in the San Diegan forms, which go over the ridge and range down upon the desert side. The invasion of all the species is along continuous associations of vegetation, but the two desert forms, *Callisaurus ventralis* and *Crotaphytus wislizenii*, occur also in the isolated association or desert "island" at Vallevista. Table II details the faunal distribution of species.

The representation in the two faunas by a species in one and a species, sub-species, or race, in the other does not attract one's attention in considering the reptiles of this area except in two cases. *Sceloporus magister* and *Sceloporus orcutti* are closely related species, the one in the Colorado and the other in the San Diegan fauna. Around Snow Creek and Dos Palmos the two inhabit the same geographical area but maintain here their specific identity. The explanation of this would seem to me to rest in the fact that they inhabit different associations of vegetation. However, the *Sceloporus orcutti* of the San Jacinto Region in general shows a greater degree of keeling on the dorsal scales, thereby approaching *S. magister*, than does *S. orcutti* of other regions. The second case is that of *Cnemidophorus tigris* and *C. stejnegeri*. *C. tigris* is reported from Palm Springs (Stone, 1911, p. 231) and occurs eastward on the desert. *C. stejnegeri* was found on the western side and through the Pass to Snow Creek. The ranges of the two species probably meet near Snow Creek. At

Snow Creek were captured specimens referred by me to *C. stejnegeri* but which varied little from *C. tigris*. It seems probable to me that in these two species we may have an illustration of the development through the modifying influences of light, temperature, and humidity of characteristics which have been described in specimens from widely separated areas and given the standing of specific characters. Where, however, these two have come into a common environment these specific differences have become less pronounced.

TABLE II

1. Species occurring in both Colorado and San Diegan faunas.

Uta stansburiana	Salvadora grahamiae
Bascanion flagellum frenatum	(?) Rhinocheilus lecontei

2. Species occurring in one fauna and not invading the other:

Colorado Fauna	*San Diegan Fauna*
Sauromelas ater	Verticaria hyperythra beldingi
Sceloporus magister	Eumeces skiltonianus
Phrynosoma platyrhinos	Pituophis catenifer
Crotalus cerastes	Diadophis amabilis

3. Species passing from one fauna into the other:

From Colorado into San Diegan	*From San Diegan into Colorado*
(*a*. Invading San Gorgonio Pass a short distance):	
Callisaurus ventralis	Phrynosoma blainvillei blainvillei
Crotaphytus collaris baileyi	Gerrhonotus scincicauda ignavus
Crotaphytus wislizenii	Lampropeltis boylei
Uta mearnsi	Bascanion laterale
	Crotalus lucifer

(*b*. Invading entire length of San Gorgonio Pass and also around Dos Palmos):

Crotalus mitchelli	Sceloporus biseriatus
	Sceloporus orcutti
	Cnemidophorus stejnegeri
	Lichanura roseofusca
	Thamnophis hammondi
	Crotalus ruber

The San Jacinto mountains are separated from the San Bernardino mountains merely by a narrow pass of Lower Sonoran character, from three to five miles in width. Most of the San Jacinto and San Bernardino species, as might be expected, are identical, yet we find in the San Jacintos as characteristic of that region and not appearing in the San Bernardinos (Grinnell, 1908, pp. 160–170) the following

species, all of which range in Lower Sonoran: *Uta mearnsi*, *Sceloporus orcutti*, *Verticaria hyperythra beldingi* and *Crotalus ruber*. A report has been made by Dr. Van Denburgh (1912, p. 149) of *S. orcutti* from material collected in 1887 or 1889 in Waterman's Cañon, San Bernardino mountains. Strictly speaking, on the basis of this record, *S. orcutti* would be excluded from the above list, but inasmuch as no collection of *S. orcutti* since 1889 in the San Bernardino mountains has been recorded, this species does not appear to be an inhabitant of that area at the present day. Certain of the desert forms of the San Jacinto region, namely, *Callisaurus ventralis*, *Sauromalus ater*, *Rhinocheilus lecontei*, and *Salvadora grahamiae* were not found in the San Bernardino area, but it is entirely possible that they may still be in that part of the San Bernardinos of desert character, which is just across the pass from Whitewater. In the San Bernardino mountains at higher levels were found forms not yet known in the San Jacintos, namely, *Thamnophis elegans* and *Eumeces* (sp. ?). This skink was recorded as *Eumeces gilberti* (Grinnell, 1908, p. 163). Re-examination makes the previous determination questionable, but the true status of the species remains to be worked out.

In a field observation of the reptiles of San Jacinto one can not help noticing certain general features in coloration. On the glaring white sand of the desert the extremely light background color of the reptiles and the main dorsal patterns of black and shades of gray and brown give a high degree of protective coloration to such species as *Callisaurus ventralis*, *Phrynosoma platyrhinos* and *Crotalus cerastes*. Associated with the dryness and intense light of the desert environment seems to be the sharp contrast of extremes of light and dark in the color patterns of the reptiles. With the colors of the yellow, buff and brown sands of the higher levels and of the Pacific area the ground colors of *Phrynosoma blainvillei blainvillei*, *Cnemidophorus stejnegeri*, *Lampropeltis boylei* and *Crotalus ruber* harmonize, while the patterns themselves have the darker shades of that group of colors. In the yet higher altitudes in the Transition zone, where the light is subdued by the large amount of shade and the dark colors of the foliage and where the air is more humid, the darkening of color and softening of pattern outlines is observed in *Sceloporus biseriatus*, *Sceloporus graciosus* and *Crotalus lucifer*. Of course in some localities there are exceptions to these general statements, both in individuals and species. Again, in *Sceloporus orcutti* the females and juvenals in their browns and greens are effectively concealed against the trunk

of a tree, yet the large black males on the light rocks are exceedingly conspicuous. On the whole, however, the general background colors of the country seems to be reflected in the general coloration of the reptiles.

Zoological Laboratory, Mills College, California.

Transmitted March 7, 1913.

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AN ACCOUNT OF THE MAMMALS AND BIRDS OF THE LOWER COLORADO VALLEY

WITH ESPECIAL REFERENCE TO THE DISTRIBUTIONAL PROBLEMS PRESENTED

BY
JOSEPH GRINNELL

UNIVERSITY OF CALIFORNIA PRESS
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INTRODUCTION

The southeastern frontier of California lies in the heart of a vast desert region possessing a fauna and flora of notable variety and peculiar specialization of forms. Cutting through the center of this desert area flows the great Colorado River. Politically, this river

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marks the southeastern boundary of California, comprising the interval between the Nevada line and the Mexican line, and separates our state from Arizona. Biogeographically, the Colorado River completely bisects the desert area through which it flows, the resultant two divisions with their xerophilous fauna and flora being separated, not only by the stream itself, but also by the riparian strips of more or less width which flank the river immediately on either side.

Two objects were in mind to justify the selection of the Colorado valley for extended field-work in vertebrate zoology: (1) The literature pertaining to the birds and mammals of the region was fragmentary, relatively little work having been published since the early and incomplete reports of Woodhouse (1853), Cooper (1861, 1868, 1869), and Coues (1866). An extended knowledge of the composition of the vertebrate fauna of the southeastern frontier of California was a desideratum. (2) The effect of the Colorado River, with its riparian strips sharply contrasted against the contiguous desert areas, upon the distribution of the animals concerned, promised to provide data of importance relative to the general problem of barriers.

Miss Annie M. Alexander, founder of the California Museum of Vertebrate Zoology, not only warmly approved of the plan to undertake field-work along the lower Colorado River with the above objects in view, but generously provided the necessary cost of the expedition in addition to her regular appropriation for the support of the museum. The plan was carried out in the three months of 1910 from February 15 to May 15, inclusive. The writer took part in the field work in person throughout the entire time, and was assisted by Mr. Frank Stephens, Mr. Joseph Dixon, and Mr. L. Hollister Jones. The party began work at Needles, and proceeded by boat from place to place down the river, the last station being on the California side below Yuma and close to the Mexican line. The locations of the various collecting stations established are given in the itinerary.

The three months' field-work yielded 1,272 specimens of mammals, 1,374 birds, 443 reptiles and amphibians, 22 sets of birds' eggs and nests, a few fishes, and a collection of the more conspicuous plants. All of this material now forms part of the collections of the California Museum of Vertebrate Zoology, except the plants, which are deposited in the Herbarium of the Department of Botany of the University of California, and the few fishes, which are added to the ichthyological collection in the Zoological Department of Leland Stanford Junior University.

The present paper concerns itself with the mammals and birds of the region, and is based upon the collections and field-notes obtained in 1910, as above enumerated. No attempt has been made as yet to work up the reptiles and amphibians, though these promise interesting results. The writer's efforts have been concentrated upon the mammals and birds, with a view to establishing first of all the systematic status of the various included forms; in other words, to determine their relationships with similar species or races of the surrounding regions. Such determination has been performed in a manner wholly satisfactory to the writer in only a part of the critical cases. As must always obtain in work of this sort, lack of material in certain directions often puts abrupt limitations upon investigation.

The obvious principle has been followed, that no generalized treatment of a concrete subject like geographic distribution is justifiable upon any but the soundest basis of systematic analysis.

Because of the close dependence of most mammals and birds upon plants, the latter have an important place in any treatment of animal distribution. The set of plants secured by the Colorado River Expedition has been named by Professor H. M. Hall, of the University of California. Names so provided are used throughout the present paper, particularly in the discussion of associational areas.

My sincere acknowledgements are hereby extended to Professor Charles H. Gilbert, Department of Zoology, Leland Stanford Junior University, and to Professor Charles A. Kofoid, Department of Zoology, University of California, for critical suggestions concerning general considerations; to Professor H. M. Hall, of the University of California, for critical reading of the chapter on associations; and to Messrs. Harry S. Swarth and Walter P. Taylor, fellow staff-members in the California Museum of Vertebrate Zoology, for help from time to time on many points of detail.

ITINERARY

Our party assembled at the town of Needles, California, on the evening of February 14, 1910, and on the following day our first collecting station was established in the river bottom close by.

A scow was constructed for the transportation of our rather bulky outfit, while the skiff purchased, being a much readier means of locomotion, enabled us to traverse the river expeditiously where need be. It was found practicable to divide the party during a portion of the

time, two of the men traveling separately with the skiff and a light outfit. All members of the party were working from the same base, except where indicated otherwise. The current was depended upon almost altogether to carry our boats from station to station.

The following enumeration shows the location of the various stations established from the initial point down the river, the names by which they are designated throughout this report, and the time spent at each. For their location reference should be made to the map (pl. 3).

1. *Needles*, California side; camp in river bottom one-fourth mile east of the railroad station; February 15 to 18.

2. *Five miles below Needles*, California side; camp in river bottom in an air line probably slightly less than four miles south-southeast of Needles; February 18 to 23. In this and some other cases, even where a government map was at hand, the exact location on the flood bottom was indeterminable on the map, because of shifting of the river channel; for it frequently happens that in a single period of high water the topography of the riparian area is profoundly metamorphosed.

3. *Mellen*, Arizona side; camp on narrow mud-bar within one-fourth mile north of the railroad station locally called Topock (=Mellen, on the Needles Special Map, U. S. G. S.); February 23 to March 1. The Santa Fe railroad crosses the Colorado River at this point.

4. *Opposite The Needles*, California side; camp on high bank about one mile northwest of "B. M. 465" of Needles Special Map, U. S. G. S.; March 1 to 8. "The Needles" are a group of sharp-peaked hills chiefly on the Arizona side of the river, and must be remembered as a totally distinct locality from "Needles," the name of the railroad town fifteen miles or more to the northwest.

5. *Foot of The Needles*, Arizona side; this station was worked from the camp on the opposite side of the river. Certain members of the party rowed back and forth morning and evening to tend trap lines; March 4 to 7.

6. *Chemehuevis Valley*, California side; camp in river bottom at lower end of this valley and close to base of hills, probably near "B. M. 438" of Parker quadrangle, U. S. G. S.; March 8 to 11. With this and the succeeding two stations uncertainty exists as to exact location of our base camps. The maps we had at that time were inaccurate. The Parker quadrangle, U. S. G. S., was not issued until 1911.

7. *Lower Chemehuevis Valley*, California side; camp at edge of whirlpool and in mouth of wash emanating from low hills, probably about one mile west-northwest of "B. M. 418" of Parker quadrangle, U. S. G. S.; March 11 to 12.

8. *Above Bill Williams River*, Arizona side; camp in river bottom, probably within two miles above "Steamboat Rock" of Parker quadrangle, U. S. G. S., and hence about eleven miles northwest of the mouth of [Bill] Williams River; March 12 to 15.

9. *Parker*, Arizona side; camp at the new Santa Fe bridge; this was merely an over-night stop, and very little collecting was done; March 15 to 16.

10. *Riverside Mountain*, California side; camp at mouth of wash, close to "B. M. 405" of Parker quadrangle, U. S. G. S.; March 16 to 22.

11, 12. *Above Blythe*, California side. The party separated at Riverside Mountain, Stephens and Jones working along slowly on the lookout for beaver sign and making at least two over-night camps on the way to Ehrenberg. One of these stops, and the one by Grinnell and Dixon, were located some distance apart, in the river bottom adjacent to the mesa on the California side, and within six or eight miles above Blythe. March 22 to 24.

13. *Ehrenberg*, Arizona side; camp in river bottom within one-fourth mile below the town; March 24 to 30.

14, 15, 16. *Below Ehrenberg*, Arizona side, one station, and *near Palo Verde*, California side, two stations. The party again separated, and base camps established at three different points in the river bottom, estimated to be from ten to twenty-five miles below Ehrenberg. The changed course of the river made dependence upon maps impossible. March 28 to April 3.

17, 18. *Opposite Cibola*, California side, two stations; main camp on high bank where river swung against mesa; somewhat above, that is, to the northwest of, rather than directly opposite, Cibola; Stephens and Jones worked from a second station about five miles below the main camp, April 5 to 6. March 31 to April 6.

19. *Ten miles below Cibola*, Arizona side; camp on narrow terrace between river and mesa, about a mile below an adobe ruin; April 6 to 10.

20. *Twenty miles above Picacho*, California side; camp in river bottom opposite Lighthouse Rock, and about a mile below the Draper ranch. In an air line this station was probably somewhat less than twenty miles north of Picacho. April 10 to 17.

21. *Eight miles east of Picacho*, California side; camp in river bottom at lower end of "Charlie's Valley," which in turn is just below Canebrake Cañon. Because of the eastward swing of the river in the vicinity of Picacho, eight miles *east* of Picacho is also eight miles *below* Picacho. April 17 to 21.

22. *Five miles above* (or north of) *Laguna*, Arizona side; camp in river bottom near base of first hills above silted-in area; April 21 to 26.

23. *Four miles above* (or north of) *Potholes*, California side; visited April 23, from our camp on the opposite side of the river.

24. *Potholes*, California side; camp in river bottom just below the head-gate; April 26 to 29.

25. *Four miles below Potholes*, California side; camp in river bottom; Grinnell and Dixon; April 29 to May 2.

26. *Five miles northeast of Yuma*, California side; camp in river bottom; Stephens and Jones; April 30 to May 3.

27. *Five miles above (northeast of) Yuma*, California side; camp in river bottom; Grinnell and Dixon; May 2 to 5. This station was but a half-mile or so from the preceding.

28. *Yuma*, Arizona side; camp about half a mile up the Gila River from its mouth, on the shore towards Yuma and within two miles east of that town; Stephens and Jones; May 3 to 7.

29. *Near Pilot Knob*, California side; camp on river bank at site of the old Hanlon Ranch, marked by a group of date palms. This is also the site of the "American Girl Pump," of the Yuma quadrangle, U. S. G. S.; but only rusting machinery and pipes, and a pile of ashes, marked the place at the time of our visit. Grinnell and Dixon; May 5 to 15; Stephens and Jones, May 7 to 15. The season's field-work was concluded on May 15.

As will have been noted, our collecting stations were usually established on alternate sides of the river successively. It proved impossible to propel the heavy scow directly across because of the strong current. In two places, however, a limited amount of collecting was done on exactly opposite sides of the river, this being accomplished through the use of the skiff alone.

From each of the base camps as a center, hunting and trapping were carried on as far radially as proved practicable. It was our effort to test every sort of ground available, that is, each association represented. Three of the four members in the party were constantly engaged in trapping for mammals. Trap lines were run in different directions, usually from the river's edge back to the highest parts of

the desert within reach, generally not farther than two miles from camp.

It was, of course, possible to carry a single day's hunt much farther back on to the desert. A distance of from four to seven miles from the river was occasionally reached in day's tramps, for instance, at Riverside Mountain, twenty miles above Picacho, and at Pilot Knob.

In the nature of the case, our camps were always pitched on the river bank where convenient landings could be made and the boats tied up safely. As is to be expected, the writer now regrets that extended work was not done at certain points scarcely or not at all touched in our 1910 exploration. It would have been a desirable thing to work intensively on directly opposite sides of the river, where it cut through high ground, at three or more points; for example, at The Needles, below Cibola, and at the Laguna Dam.

It must be remembered, however, that we had practically no information to start with, either as to the fauna or local topography along most of the route. We had it all to learn by our own efforts; and only as experience accumulated could the contrasting sets of facts come into relief, thereby directing our enquiries into more productive channels.

DESCRIPTION OF THE COLORADO RIVER

The portion of the Colorado River explored by the 1910 expedition is altogether below the famed Grand Cañon. There is no true "cañon" below the Nevada line, the river flowing through its channel in relatively sober fashion. Yuma is very close to 150 miles in a direct line due south of Needles. While following a general north-to-south course, the many deflections of the river, and especially its meandering through the big valleys, make the distance from Needles to Yuma by the way of the river approximate 285 miles. The altitude of the river at Needles is 460 feet, at Yuma, 125 feet, so that the average fall in this portion of the river is only a little more than one foot per mile.

Two features of the Colorado River are extraordinary, when comparison is made with other streams of the North American continent. (1) The amount of sediment always carried in suspension is very great, so that the flowing waters are quite opaque at all seasons of

the year. (2) There is an enormous increase in the volume of the river at the annual period of high water (see Newell, 1904, pp. 123–161).

The sediment load varies from one-tenth to two and one-tenth per cent, by weight, according to the rate of the current. The latter varies from a maximum of two and one-half miles per hour at low water up to even seven miles per hour at flood time in parts of the channel where conditions are most favorable. While it is probable that the Needles-to-Yuma section of the Colorado River has about reached grade, the extraordinary supply of sediment always fed from above and the ever fluctuating volume of water, result in a continued process of deposition and erosion, going on simultaneously in different parts of the river's channel. At low water deposition exceeds erosion, but at flood time the increased transporting power of the river results in removal of large masses of soil from varying parts of the river bottom.

The flow of the river varies from 4,000 to 100,000 cubic feet per second. The time of lowest water is in midwinter, that of highest flood, in June, at the time of melting snow among the sources of the Colorado River, in the Rocky Mountains. The period of high water is of short duration, about May 15 to July 1, while throughout the year fluctuations of less extent are liable to occur at any time.

The river's course is of two markedly different types: where it flows between rock walls among hills the channel is of fixed location and usually deep and narrow; in the large valleys the river may be broad and shallow, but at any rate of constantly shifting channel. At The Needles the river passes between high hills and the narrow channel thus formed has two sharp bends in it. Such a gorge is locally called a "box cañon," and at certain stages of the river is not without danger to small boats because of whirlpools and jutting reefs of rock. At low water the voyager is astonished at the elevation of the highest water marks on the rock walls above the surface of the river at the low stage.

There is good reason for believing that the river is now aggrading its channel considerably above the apex of the delta where, of course, this process is certainly in progress. At any rate, sedimentation has formed broad flood-bottoms at intervals along the river's course. These, large or small, are very similar in physical and floral features.

The most extensive one of these flood-bottoms is sometimes known as the "Great Valley of the Colorado." The settlements of Blythe,

Ehrenberg, Palo Verde and Cibola are located in it, and considerable activity has of late been directed towards farming the rich bottom lands. But the capriciousness of the river has proven a hindrance to marked development along this line.

Shortly below the point where the river emerges from its rock-confined channel into the broadening valley, meandering begins. The detours of the stream increase in extent towards the lower end of the valley, the channel swinging from side to side in great curves, marked by minor curves along these courses, so that a sort of periodicity of meandering is exhibited. The most notable phenomenon in this connection is the progressive movement of these loops down the valley. The result is that in a short period of years, the major portion of the river's flood-bottom is worked over in the path of this irresistible and continual shifting of the channel.

The effect on the flora is obvious. Only in curves of the valley sheltered by abutting hills are trees given a chance to reach advanced age. The only trees capable of thriving on the unstable portion of the flood-bottom are such as grow rapidly, willows and cottonwood. As the observer floats along the main channel, winding through the great valley, especially during rising water, the destructive process in question is clearly in evidence. On the outside of each curve the river rapidly undercuts the bank, dislodging great masses of the fine sedimentary soil, itself laid down but a few years previously. The overgrowth of comparatively aged willow and cottonwood topples into the stream and is swept away by the swift current. Hundreds of acres may be thus appropriated by the river in a few days and within a short distance.

On the other hand, on the inside of each curve, where the current is slow, and especially during falling stages of the water, the river is rapidly depositing sediment, in other words building up its bank towards the general level of the bottom lands. At the annually recurring periods of high water, when the entire flood bottom is inundated, layers of silt are deposited over the whole, thus tending to establish a uniform level.

The observer, from any appropriate hill-top overlooking the valley, can readily discern the regularly graded heights of tree growth which mark the successive ages of the land on which they grow. The year-old seedlings but a few inches in height form a crescent-shaped belt along the inside of each curve of the river, facing down the valley. Paralleling this and next in position back from the river is dense

two-year-old growth, succeeding which is a stand of still older growth. Because of the progressive trend of the process it is as a rule the oldest growth which becomes subject to the razing action of the river as its loops travel down the valley.

Occasionally cut-offs occur, thus interrupting the symmetry of behavior, and the river quickly establishes a new channel, portions of the old being left as lagoons, though these are usually short-lived because of the rapid sedimentation at recurring times of general overflow. The bottom land immediately adjacent to the channel, where the latter has been fixed for some time, is usually higher than the lateral tracts. The depressions on one or the other side of the flood-bottom are generally drained at the lower end of the valley by a series of sloughs emptying into the main channel just above the constriction of the valley where the hills converge.

At high water these lateral depressions are submerged to a depth of as much as twelve feet, as shown by actual measurement of the upper limit of the mud marks on the tree trunks. Whatever the water touches is discolored by a coat of fine sediment, and one thereby gains at any time of the year an accurate estimate of the depth of inundation in any part of the flood bottom at the previous period of high water (see sectional profiles, figs. A and B).

In some places the overflow depressions have no drainage outlets. After times of flood, the water in them disappears by evaporation, which proceeds at a very rapid rate in this excessively arid and hot region. Areas of alkaline deposits are left, often stretches of bare, baked hard-pan surrounded by concentric belts of halophilous vegetation.

At rather infrequent intervals along the large valleys the river, in swinging, cuts beyond its usual limit and assaults the desert mesa. The process tends to add to the area of the regular flood plain and conduces to the formation of lateral bluffs. It is noteworthy that this aggressive work of the river is much more conspicuous on the *west* side of each valley than on the east side. The law of westward cutting of north-and-south flowing streams in the northern hemisphere, as brought about by the earth's rotation, is thus clearly illustrated in the Needles-to-Yuma section of the Colorado River.

The local use of the terms "first bottom" and "second bottom" in the large valleys is worth adopting in general discussions relative to ranges of animals. The first bottom is the portion of a valley subject to regular overflow, and is clearly marked by the presence of

willows and cottonwood; the second bottom is of sufficiently higher elevation to be chiefly above high-water mark, and is characterized by mesquite, salt-bush, and rank clumps of creosote bush. The second bottom may be altogether wanting, or it may constitute a broad bench-like tract. The surface is often modified by alluvial deposits at the mouths of washes leading down from the adjacent desert, and by wind-blown sands which heap up about bushes, especially along the southeastern borders of the valleys.

The Laguna Dam has had a pronounced modifying influence on the flora and fauna of the vicinity. The dam was built to a height of twelve feet above the mean level of the river at that point at the time of beginning construction. As soon as it was completed (in 1909) the retarded waters above began to deposit silt, and by May, 1910, the valley above had been silted in to a depth determined by the top of the dam. The water level had been raised conspicuously for at least ten miles, and we saw evidences of deepening of the first bottom deposits and slowing of current for fully thirty miles, above the dam. The cottonwoods of the first bottom within eight miles above the dam had all been killed, evidently by the raising of the general surface around their trunks; and the mesquites and other vegetation of the second bottom had all been drowned out, there thus being no trace of second-bottom conditions except for dead stalks. These were replaced by vast mud flats growing up to arrowweed. All this change, of course, involved the birds and mammals of the areas affected, in addition to the plant life.

Below the dam reverse changes took place. The water, having dropped a considerable portion of its sediment above the dam because of the slowing of its current, was able to pick up sediment at a correspondingly accelerated rate below the dam. This, and the fact of a new cut-off having been found by the river in the delta in 1909, thus temporarily shortening its channel, resulted in a deepening of the channel seven feet below the previous level immediately below the dam. Thus the former flood-bottom was, in 1910, far above flood level, and in a way to become good second bottom, with appropriate metamorphosis in vegetation and fauna.

Although these changes were local, and due to man's interference, similar ones, due to natural causes, have doubtless occurred from time to time in various parts of its course in the river's history, thus repeatedly shifting the riparian strips both in position and total width, with corresponding variability in the powers of the river at different

points to act as a barrier to the dispersal of some animals and as a highway of dispersal for others.

The effects of the extraordinary and continuous load of sediment of the Colorado River, together with the inconstancy of its channel, doubtless account directly or indirectly for many of the peculiarities in the fauna. As far as known to the writer, in the Needles-to-Yuma section of the river valley there are no aquatic molluscs or decapod crustaceans, or tailed amphibians. Toads and frogs are present but not abundant. The fish fauna in the main stream is sparse in both species and individuals.

Our party seined at three different points in the main stream. At two of these nothing was caught; in the third, a backwater slough on the Arizona side above Mellen, four sorts of fishes were taken, catfish (*Ameiurus nebulosus*), bony-tail (*Gila elegans*), hump-backed sucker (*Xyrauchen cypho*), and carp (*Cyprinus carpio*). A huge minnow (*Ptychocheilus lucius*), called locally "Colorado salmon," was caught with hook and line in back-water on the California side opposite Cibola, and was plentiful immediately below the Laguna dam, where many were being taken by the Indians living near there. In lateral sloughs and overflow depressions carp and catfish were often observed in numbers, and in these relatively clear waters they were far more accessible to piscivorous animals than in the opaque water of the river itself. It may be said, in conclusion, that the portion of the Colorado River under consideration has relatively a very poor aquatic fauna and flora, and that this poverty has had its effect in limiting the occurrence of vertebrate animals dependent upon such sources of food-supply.

ZONAL AND FAUNAL POSITION OF THE REGION

Two schools of faunistic students are represented among American zoogeographic writers of the present day. One, of which C. H. Merriam (1894, etc.) is the most prominent exponent, sees in temperature the chief controlling cause of distribution, and deals with the ranges of species in terms of "life-zones." The other school, of which C. C. Adams (1905, etc.), A. G. Ruthven (1907), and Spencer Trotter (1912) are active advocates, assigns to temperature but a minor role, looking rather to a composite control, of many factors, resulting in ecologic "associations," of which plants are essential elements, and which are

to be further explained on historical grounds. The two sets of areas thus defined do not by any means correspond. Yet the reviewer cannot fail to note, here and there, places where boundaries coincide, and such coincidences are so frequent as to be suggestive of real concordance in some significant manner. Is it not probable that both schools are approximately correct, the difference in mode of treatment being due to different weights given the different kinds of evidence, or, in other words, to difference in perspective? The opportunity is here taken to attempt to bring into accord the systems of the two schools.

The period of field study up to the present time devoted by the writer to the animal life of the climatically diversified state of California has led him to the recognition of *three distinct orders* of distributional behavior as regards terrestrial vertebrates. These are indicated in the terms: zonal, faunal, and associational.

Every animal is believed to be limited in distribution *zonally* by greater or less degree of temperature, more particularly by that of the reproductive season (see Merriam, 1894). When a number of animals (always in company with many plants similarly restricted) approximately agree in such limitation, they are said to occupy the same life-zone.

The observation of this category of distributional delimitation is particularly easy in an area of great altitudinal diversity like that comprised in the southwestern United States. The writer is led to wonder if those authors who minimize the importance of temperature have ever been privileged to travel, and *carry on field studies*, outside of the relatively uniform eastern half of North America!

Study of any area which varies widely in altitude and hence provides readily appreciable differences in daily temperature from place to place brings conviction of the very great effectiveness of temperature in delimiting the ranges of nearly all species of animals as well as of plants. Particular attention may be called to the results of a biological survey of Mount Shasta (Merriam, 1899).

But temperature is not to be considered the only delimiting factor of environment, though its possible overemphasis by the Merriam school seems to have led some other persons to believe that this view is held. In fact, it becomes evident after a consideration of appropriate data that very many species are kept within geographic bounds in certain directions only by an increasing or decreasing degree of atmospheric *humidity* (see Grinnell and Swarth, 1913, p. 217). By

the plotting of the ranges of many animals as well as of plants, coincidence in this regard is found in so many cases as to warrant the recognition of a number of "faunal areas," on the causative basis of relative uniformity in humidity. It is probable that every species is affected by both orders of geographic control.

As to which is the *more* important, assembled data seem to show that more genera and higher groups are delimited by zonal boundaries than by faunal boundaries (see Merriam, 1892, p. 49, etc.) The arresting power of temperature barriers would therefore seem to be relatively the greater.

In the third category of distributional control there is a conspicuous association of the majority of so-called adaptive structures of animals (often of high taxonomic value) with certain mechanical or physical features of their environment. An animal may thus intimately depend upon certain peculiarities, inorganic or organic, or both, of a given area, and be unable to maintain existence beyond the limits of occurrence of those features of the environment. For instance, *Dipodomys deserti* is delimited by soil of certain texture and depth. Tracts of relatively uniform environmental condition, including their inanimate as well as living elements, are here called *associations*.

The geographical distribution of any animal is correctly diagnosed in terms of each of the above three groupings. In other words, an animal belongs simultaneously to one or more zones, to one or more faunas, and to one or more associations. No one of these groupings can be stated in terms of the other, any more than a person can compute liquids by the peck, or weight in miles. The constituent species within each of these groupings always belong to the other two. To illustrate: the southern white-headed woodpecker inhabits the coniferous forest association of the San Bernardino fauna of the Transition zone; the Abert towhee belongs to the mesquite and quail-brush associations of the Colorado Desert fauna, of the Lower Sonoran zone; the Pacific shrew belongs to the upland riparian association of the northern coast redwood fauna of the Transition and Boreal zones.

Referring now to the region contiguous to the lower Colorado River, we have good reason, both biotic and meteorologic, for assigning it all to one zone, namely, the Lower Sonoran, and to one fauna, the Colorado Desert; but many associations are represented. In other words, the variation in altitude and latitude included is not great enough to bring sufficient modification of the characteristically high temperature to affect profoundly the distribution of the plant and

animal life within the region. Nor is there marked variation in atmospheric humidity, the entire area being swept by air currents of prevailing dryness. To express the situation in a different way, zonal and faunal conditions are remarkably uniform; but associational conditions are varied, as pointed out in the succeeding chapter.

The zonal diagnosis, Lower Sonoran, is based in part upon the presence of the following determinative genera:

MAMMALS	BREEDING BIRDS
Ammospermophilus	Melopelia
Sigmodon	Micropallas
Dipodomys	Geococcyx
Perognathus	Centurus
Pipistrellus	Calypte
Macrotus	Pyrocephalus
	Guiraca
	Phainopepla
	Toxostoma
	Auriparus
	Polioptila

The faunal diagnosis, Colorado Desert, is based in part upon the presence of the following subspecies and species, selected from the entire list as being particularly restricted:

MAMMALS	BREEDING BIRDS
Odocoileus hemionus eremicus	Lophortyx gambeli
Citellus tereticaudus tereticaudus	Otus asio gilmani
Peromyscus eremicus eremicus	Bubo virginianus pallescens
Reithrodontomys megalotis deserti	Dryobates scalaris cactophilus
Neotoma albigula venusta	Centurus uropygialis
Thomomys albatus	Colaptes chrysoides mearnsi
Dipodomys deserti deserti	Agelaius phoeniceus sonoriensis
Perognathus spinatus spinatus	Melospiza melodia saltonis
Perognathus penicillatus penicillatus	Pipilo aberti
Perognathus intermedius	Piranga rubra cooperi
Lepus californicus deserticola	Vireo belli arizonae
Felis oregonensis browni	Vermivora luciae
Canis ochropus estor	Dendroica aestiva sonorana
Vulpes macrotis arsipus	Toxostoma crissale
Mephitis estor	Polioptila plumbea
Procyon pallidus	
Myotis occultus	
Myotis californicus pallidus	

The picked zonal and faunal "indicators" just named are often found in the same association with other elements seemingly less sensitive to temperature and humidity. Some of the latter, however,

may be present under duress, since their greatest abundance is known to be in adjacent zones or faunas. Thus *Lynx* and *Eptesicus* are much more plentiful in the Upper Sonoran zone or even in the Transition zone; and, on the other hand, *Sigmodon* and *Pyrocephalus* are genera of subtropical abundance. The presence of elements of the latter category was probably what led Merriam at one time (1894, p. 233, footnote, pl. 14) to refer the lower Colorado River Valley to the Tropical zone. All students who employ the life-zone system, now unhesitatingly agree in referring the area in question to the Lower Sonoran zone.

The "western desert tract," of Mearns (1897, pl. 2), is probably similar to the "Colorado Desert fauna" of the present paper. The former term is not considered apropos in the system adopted by the present writer on the ground that an inanimate *area* is designated thereby, rather than an assemblage of living things inhabiting the area.

ASSOCIATIONAL AREAS OF THE REGION

Since the entire region under consideration all belongs to one zone and all to one fauna, according to the definitions of these distributional terms given in the preceding chapter, the study of local distribution in the Colorado River region pertains chiefly to associations. Perhaps nowhere else in America can one find the degree of associational contrast which is presented in the region under consideration. A stream of large volume, with paralleling strips of well-watered bottom land, maintains its course to the sea through what is considered the hottest and most arid desert in the world.

There is nothing to show that the atmosphere is appreciably more humid in the vicinity of the bottom lands or the river itself than upon the open desert. The evaporated moisture is quickly dissipated; that is, it becomes diluted to an imperceptible proportion in the desert air currents. It appears, therefore, that the great floral differences observed between the extreme associations are due primarily to difference in amount of soil water available. There are, of course, such additional factors as varying alkalinity, and shade (see Spaulding, 1909).

It must be understood that the associations here defined are recognized by the writer primarily because of their service in the treatment of animal distribution. Botanists have found it useful to make much

finer analysis (for example, see Spaulding, 1908). A more or less detailed description of the associations observed in our 1910 explorations is herewith offered, as a necessary prelude to further discussion.

In the lists of species, grouped according to apparent associational preferences, all mammals found by our party are included, and all the birds treated in the "General Accounts" except sixteen species, which are of transient occurrence and uncertain forage-ground like swallows, or else so rare as to make even approximate appraisement impossible.

Qualifying terms are appended in each case: whether of exclusive (excl.) occurrence in the association under discussion, or of maximum (max.) abundance, or of minor (min.) abundance. Obviously a species of *exclusive* occurrence is entered in but one of the associational lists, while one marked *max.* in one list is to be found marked *min.* in one or more of the other lists. It is to be taken for granted that in species of easy locomotion, *individuals* may occur in transit across other associations than the one or ones in which it is characteristically present *en masse*.

There is necessarily more or less uncertainty in many cases, and where the doubt is strong, owing to lack of knowledge, a question mark is added. With birds, seasonal occurrence is indicated by the terms: resident (present throughout the year), winter (present throughout the winter, in certain cases including fall and spring also), summer (present during the breeding season, in certain cases including spring and fall also), transient (merely passing through during migration).

River Association

BIRDS

Gavia immer: excl.; winter
Sterna forsteri: excl.; transient
Phalacrocorax auritus albociliatus: excl.; winter and transient
Pelecanus erythrorhynchos: excl.; winter and transient
Mergus serrator: excl.; winter
Anas platyrhynchos: excl.; winter
Nettion carolinense: excl.; winter
Querquedula cyanoptera: excl.; transient
Spatula clypeata: excl.; winter
Dafila acuta: excl.; winter
Marila affinis: excl.; winter
Erismatura jamaicensis: excl.; winter
Chen hyberboreus hyperboreus: excl.; winter
Plegadis guarauna: excl.; transient
Myeteria americana: excl.; summer
Ardea herodias treganzai: excl.; resident
Butorides virescens anthonyi: excl.; transient
Nycticorax nycticorax naevius: excl.; resident
Grus canadensis: excl.; winter (?) and transient
Fulica americana: min.; transient

Pisobia minutilla: excl.; winter
Actitis macularius: excl.; winter
Oxyechus vociferus vociferus: min.; transient
Circus hudsonius: min.; winter
Pandion haliaëtus carolinensis: excl.; transient
Ceryle alcyon: excl.; transient
Sayornis nigricans: excl.; winter
Corvus corax sinuatus: max.; resident
Petrochelidon lunifrons lunifrons: excl.; summer
Stelgidopteryx serripennis: min.; summer
Anthus rubescens: excl.; winter

MAMMALS

Castor canadensis frondator: excl.
Ondatra zibethica pallida: max.
Procyon pallidus: max.

Remarks upon the River Association.—For reasons already explained there is relatively little cryptogamic aquatic flora in the Colorado River. There is therefore little or no food-supply from this source to attract plant-eating ducks. This category of water-birds was, in fact, very sparsely represented.

On the other hand, herons were notably plentiful because of the supply of catfish and carp made abundant at intervals by the drying-up of overflow ponds. While fishes were not abundant in the main stream, they were plentiful in backwater sloughs, where, too, the water was more nearly clear because the sediment had a chance to settle out.

The ornis of the river appeared to owe its proportionate consistency in large measure to the above two circumstances, namely, poverty in aquatic plant life, and sporadic abundance of certain fishes in the lateral sloughs (see p. 62).

The single carnivorous mammal (*Procyon*) belonging chiefly to the river association was piscivorous in food habits, foraging along mud bars (see pl. 4, fig. 2) and at the margins of overflow ponds and sloughs, as do the herons. The two rodents of the river and larger paralleling sloughs, which are here included as part of the River Association, lived in banks immediately adjacent to the water. The beaver fed chiefly upon bark, twigs and foliage of such willows and cottonwoods as had fallen over into the water through being undermined by the current.

Willow-Cottonwood Association

BIRDS

Melopelia asiatica trudeani: excl.; summer
Accipiter velox: max.; winter
Accipiter cooperi: excl.; resident
Buteo borealis calurus: min.; resident
Falco sparverius phalaena: min.; resident
Otus asio gilmani: max.; resident
Bubo virginianus pallescens: min.; resident
Dryobates scalaris cactophilus: max.; resident
Sphyrapicus varius nuchalis: min.; winter
Centurus uropygialis: min.; resident
Colaptes cafer collaris: excl.; winter
Colaptes chrysoides mearnsi: min.; resident
Phalaenoptilus nuttalli nuttalli: max.; winter (as a forager only)
Phalaenoptilus nuttalli nitidus: max.; resident (?) (as a forager only)
Chordeiles acutipennis texensis: min.; summer (as a forager only)
Archilochus alexandri: max.; summer
Tyrannus verticalis: excl.; transient
Myiarchus cinerascens cinerascens: min.; transient
Nuttallornis borealis: excl.; transient
Myiochanes richardsoni richardsoni: max.; transient
Empidonax difficilis difficilis: excl.; transient
Empidonax trailli trailli: excl.; summer
Empidonax hammondi: excl.; transient
Empidonax wrighti: excl.; transient
Empidonax griseus: max.; winter
Pyrocephalus rubinus mexicanus: min.; resident
Molothrus ater obscurus: max.; summer
Xanthocephalus xanthocephalus: min.; winter
Agelaius phoeniceus sonoriensis: max.; resident
Icterus cucullatus nelsoni: max.; summer
Icterus bullocki: max.; summer
Zonotrichia leucophrys gambeli: min.; winter
Spizella passerina arizonae: min.; transient (?)
Melospiza melodia fallax: min.; winter
Melospiza melodia saltonis: min.; resident
Melospiza lincolni lincolni: min.; winter
Pipilo aberti: min.; resident
Oreospiza chlorura: max.; transient
Zamelodia melanocephala melanocephala: max.; transient
Guiraca caerulea lazula: min.; summer
Passerina amoena: excl.; transient
Piranga ludoviciana: max.; transient
Piranga rubra cooperi: excl.; summer
Vireosylva gilva swainsoni: max.; transient
Lanivireo solitarius cassini: max.; transient
Vireo belli arizonae: max.; summer
Vermivora ruficapilla gutturalis: excl.; transient
Vermivora celata celata: max.; winter
Vermivora celata lutescens: excl.; transient
Dendroica aestiva sonorana: excl.; summer
Dendroica aestiva brewsteri: excl.; transient
Dendroica aestiva rubiginosa: excl.; transient
Dendroica auduboni auduboni: max.; winter
Dendroica nigrescens: max.; transient
Dendroica townsendi: max.; transient
Dendroica occidentalis: excl.; transient
Geothlypis trichas scirpicola: min.; resident

Icteria virens longicauda: excl.; summer
Wilsonia pusilla pileolata: max.; transient
Wilsonia pusilla chryseola: min.; transient
Troglodytes aedon parkmani: excl.; winter
Regulus calendula cineraceus: excl.; winter
Polioptila caerulea obscura: min.; winter
Hylociehla ustulata ustulata: excl.; transient
Hylociehla guttata guttata: excl.; winter
Planesticus migratorius propinquus: max.; winter

MAMMALS

Odocoileus hemionus eremicus: min. (?)
Peromyscus maniculatus sonoriensis: max.
Sigmodon hispidus eremicus: max.
Reithrodontomys megalotis deserti: min.
Sylvilagus audubonii arizonae: min.
Felis oregonensis browni: max.
Urocyon cinereoargenteus scotti: max. (foraged in all other riparian associations)
Mephitis estor: min.
Procyon pallidus: min.
Antrozous pallidus pallidus: max. (?)
Myotis occultus: max. (?)
Nyctinomus mexicanus: max. (?)

Remarks upon the Willow-Cottonwood Association.—The predominating plants in this association were: willows of at least two species (*Salix nigra* and *Salix fluviatilis*), the cottonwood (*Populus fremonti*), and guatemote (*Baccharis glutinosa*). The latter occurred chiefly as an undergrowth where the willows or cottonwoods had reached large size. Practically all of the area occupied by this association is subject to inundation annually in early summer, of from a few inches to as much as twelve feet. Only such plants as can survive this period of drowning are able to occupy the flood-bottom of the river.

Furthermore, as explained in the general description of the river (p. 59), much of the overflow bottom is subject to destructive erosion through continual changing of the river's channel. By this process all vegetation in its path is swept away at frequent intervals. Only such trees as are of rapid growth are able to maintain a representation on the major part of the bottom lands.

No plants of the willow-cottonwood association (or it may be more briefly referred to as simply the willow association) occurred also on the upland deserts, and conversely no true desert plant occurred in the overflow area. Only one possible exception was observed, the screwbean (*Prosopis pubescens*) which occurred in mixture with willows in a few places, where the flood-bottom was old, that is, had not

been swept by channel-swinging for a long period of years. However, in the vicinity of the Colorado River, we failed to observe the screwbean outside of the willow association, although it is known to occur in the mesquite and even the catclaw associations elsewhere; so that here the screwbean may be considered a restrictedly riparian plant.

One other plant of the willow association requires mention—the cane (*Phragmites communis*), which grows in dense jungles on permanent portions of the river bank from the vicinity of Picacho down. The tracts of cane are usually narrow, but, as in Canebrake Cañon, below Picacho, may extend continuously close along the river for miles. At the higher stages of the river the bases of the stalks are submerged, while the drooping ends trail in the water (see pl. 4, fig. 3). A verdant screen on either hand thus intercepts the view of the voyager.

The exogenous vegetation of the willow association is all of it deciduous, so that before the time of leafing-out in early March (see pl. 5, fig. 4) a very different appearance is presented from that later in the season. The spring growth is luxuriant, and accompanying it is a crop of insects which offer prolific food-supply to the abundant bird population of that season. Practically all of the birds listed for the willow association are either insectivorous or raptorial. Graminivorous or spermophilous species are notably absent.

The greater part of the fifty passerine birds listed for this association are transients or winter visitants. Only three are permanent residents. The most notable characteristic summer visitants are: *Dendroica aestiva sonorana*, *Vireo belli arizonae*, *Piranga rubra cooperi*, *Archilochus alexandri*, and *Molothrus ater obscurus*.

Since the willow association includes practically the only forest elements in the region, we find here a concentration of dendrophilous birds, other than foliage-feeders, such as woodpeckers and flycatchers. The latter, in particular, are abundant in both species and individuals, and contribute to the great contrast afforded between the life of the riverside and that on the desert which in large part lacks them.

While bird-life is conspicuously more abundant in the willow association than in any one of the desert associations, just the reverse obtains with the mammals. With the exception of the insect-feeding bats, which share with the smaller birds the benefits of the insect supply, there is but one rodent of wide and plentiful occurrence—*Peromyscus maniculatus sonoriensis*. Three other rodents occur locally, notably *Sigmodon*. Otherwise the only mammals of the willow association are far-ranging predators.

The paucity of terrestrial mammals in this association is probably due to the repressive effect of the annual overflow which cannot fail to reduce the food-supply for many days at a time, even if extensive mortality does not directly ensue through drowning of individuals.

As already implied (p. 58), the willow association varies greatly in width in different parts of the river's course. Where the channel is constricted by rock walls, as in the box cañon at The Needles, all trace of it is effaced for many rods. Where the river flows among hills patches of willows in ravine-mouths give detached representations to one or more elements. On the other hand, the broad valleys are occupied chiefly by this association which may then be as much as seven miles wide and continuous for many miles on one side or the other of the meandering channel. Taken by and large, the willow association is the most important one biotically of the entire set of associations dependent upon the presence of the river.

Tule Association

BIRDS

Fulica americana: max.; winter
Oxyechus vociferus vociferus: max.; winter
Circus hudsonius: max.; winter
Xanthocephalus xanthocephalus: max.; winter
Agelaius phoeniceus sonoriensis: min.; resident
Melospiza melodia saltonis: min.; resident
Geothlypis trichas scirpicola: max.; resident
Geothlypis trichas occidentalis: min.; transient
Telmatodytes palustris plesius: excl.; winter

MAMMALS

Sigmodon hispidus eremicus: min.
Reithrodontomys megalotis deserti: max.
Ondatra zibethica pallida: min.
Procyon pallidus: min.

Remarks upon the Tule Association.—The river's habit of overflow would be expected to result in rather extensive tracts of palustrine flora. As a matter of fact, however, marshes were few and of small size. This was probably due to the rapid rate of evaporation of overflow water so that favoring conditions did not last long, and also to the rapid silting-in of such water basins as ox-bow cut-offs. As a result there were either almost lifeless alkali depressions, or lagoons practically identical in biotic features with the main river. But in a few places there were well-defined palustrine tracts kept wet

throughout the year, chiefly by seepage. These were always located back from the river near the outer edges of the broader valleys, where they were least affected during flood time. They were marked by growths of tules, sedge, and salt-grass, sometimes the latter alone, and were usually surrounded by the arrowweed or willow association (see fig. B). The little open water sometimes attracted a few transient ducks and mudhens, but so far as known no water birds outside of the Ardeidae remain to breed anywhere along the Colorado River.

As may be noted from the list, but few animals were found to frequent the tule association regularly enough to be considered distinctive features of that association. Of these, *Reithrodontomys* was the only mammal finding its center of abundance there.

Arrowweed Association

BIRDS

Lophortyx gambeli: min.; resident (only as a forager)
Geococcyx californianus: min.; resident (only as a forager)
Astragalinus psaltria hesperophilus: min.; resident
Zonotrichia leucophrys leucophrys: min.; winter
Zonotrichia leucophrys gambeli: min.; winter
Melospiza melodia fallax: max.; winter
Melospiza melodia saltonis: max.; resident
Melospiza lincolni lincolni: max.; winter
Pipilo maculatus curtatus: max.; winter
Oreospiza chlorura: min.; transient
Vireo belli arizonae: min.; summer
Vermivora celata celata: min.; winter
Dendroica townsendi: min.; transient
Oporornis tolmiei: min.; transient

MAMMALS

Peromyscus maniculatus sonoriensis: min.
Neotoma albigula venusta: min.
Perognathus penicillatus penicillatus: min.
Sylvilagus auduboni arizonae: min.
Mephitis estor: min.
Spilogale arizonae arizonae: min. (?)

Remarks upon the Arrowweed Association.—In its purity this association possesses only one conspicuous plant, the arrowweed (*Pluchea sericea*), which, over extensive areas, grows so densely as to occupy the ground to the exclusion of everything else (pl. 5, fig. 5). This belt of arrowweed usually occupies slightly higher ground than does

the willow association, yet not above the high-water mark. It is present quite regularly as a tract along the outer margin of the willow association, often only a few feet in width, but sometimes, as for example near Pilot Knob, as much as two hundred yards in width.

The arrowweed grows to a very uniform height, varying in different places from three to over eight feet; and the slender straight stems stand so close together as effectually to bar rapid progress through the more luxuriant tracts. The plant is of perennial growth, but only during the season of blossoming, April and May, does it appear to be particularly favored by insects. In many places there is mixed willow and arrowweed, in fewer places quail-brush and arrowweed, either combination being evidently more attractive to birds than the arrowweed alone.

The only resident bird finding its maximum abundance in the arrowweed association is the song sparrow (*Melospiza melodia saltonis*). Even here the suspicion is aroused that this association is sought more for cover because of the peculiar manner of growth of the constituent plant, than as a food-producing area. For the song sparrow forages freely into both adjacent associations.

Of mammals, not one can be said to find its maximum abundance in the arrowweed association. The few species regularly trapped there were all more prominent constituents of adjacent associations. There would be little reason for the recognition of the arrowweed association as distinct from the willow association if it were not for its large extent and the conspicuous *absence* from it of a great many of the elements abundant in the latter.

Quail-brush Association

BIRDS

Lophortyx gambeli: max.; resident
Zonotrichia leucophrys leucophrys: min.; transient
Zonotrichia leucophrys gambeli: max.; winter
Melospiza melodia fallax: min.; winter
Melospiza melodia saltonis: min.; resident
Pipilo maculatus curtatus: min.; winter
Pipilo aberti: min.; resident
Oreospiza chlorura: min.; transient
Guiraca caerulea lazula: max.; summer
Oporornis tolmiei: max.; transient
Geothlypis trichas occidentalis: max.; transient
Toxostoma crissale: min.; resident
Polioptila plumbea: min.; resident

MAMMALS

Peromyscus maniculatus sonoriensis: min.
Neotoma albigula venusta: min.
Sylvilagus audubonii arizonae: max.

Remarks upon the Quail-brush Association.—The local hunters at Needles and other towns along the river apply the term quail-brush to *Atriplex lentiformis*, a plant growing in dense clumps three to eight feet in height along the outer margin of the flood-bottom. The belt of this plant is so well marked and continuous, and the important relations borne to certain animals are so evident, that the writer is led to designate it separately by the name quail-brush association (see pl. 6, fig. 6).

Atriplex lentiformis often forms pure growths of a few yards to many rods in width on ground at about the upper limit of the average annual overflow. It was seen by us only in immediate proximity to the flood-bottom, and hence was essentially a riparian element, different from the other species of *Atriplex* inhabiting the region.

The peculiar feature of the quail-brush was its compactly interlacing network of branches, so dense and resistent that a person might throw his whole weight against a thicket only to be hurled back by the elastic rebound. The value of the plant to the animals affecting it consisted pre-eminently in the protecting cover afforded. Quail and cottontail rabbits when frightened took refuge in runways or natural spaces beneath its tangled mass; and bush-inhabiting sparrows of several species seemed to find ideal shelter in it.

Although serving thus as a temporary shelter to animals regularly foraging in other associations, the quail-brush association also provided a safe breeding place for such birds as *Pipilo aberti*, *Guiraca* and *Melospiza*. In places, clumps of quail-brush alternated with mesquites, and here *Toxostoma crissale* found particularly congenial ground.

Mesquite Association

BIRDS

Lophortyx gambeli: min.; resident
Accipiter velox: min.; winter
Dryobates scalaris cactophilus: min.; resident (only as a forager ?)
Sphyrapicus varius nuchalis: max.; winter
Centurus uropygialis: min.; resident (only as a forager)
Myiarchus cinerascens cinerascens: min.; transient
Myiochanes richardsoni richardsoni: min.; transient

Empidonax griseus: min.; winter
Pyrocephalus rubinus mexicanus: max.; resident
Molothrus ater obscurus: min.; summer
Astragalinus psaltria hesperophilus: min.; resident
Astragalinus lawrencei: exel.; winter
Zonotrichia leucophrys leucophrys: min.; transient
Zonotrichia leucophrys gambeli: min.; winter
Spizella passerina arizonae: min.; winter
Pipilo aberti: max.; resident
Piranga ludoviciana: min.; transient
Phainopepla nitens: max.; resident
Vireosylva gilva swainsoni: min.; transient
Vireo belli arizonae: min.; summer
Vermivora luciae: exel.; summer
Dendroica auduboni auduboni: min.; winter
Dendroica nigrescens: min.; transient
Wilsonia pusilla pileolata: min.; transient
Wilsonia pusilla chryseola: min.; transient
Oreoscoptes montanus: max.; winter
Mimus polyglottos leucopterus: max.; winter
Toxostoma crissale: max.; resident
Heleodytes brunneicapillus couesi: min.; resident
Auriparus flaviceps flaviceps: min.; resident
Polioptila caerulea obscura: min.; winter
Polioptila plumbea: min.; resident
Planesticus migratorius propinquus: min.; winter
Sialia mexicana occidentalis: exel.; winter

MAMMALS

Odocoileus hemionus eremicus: min.
Peromyscus maniculatus sonoriensis: min.
Neotoma albigula venusta: max.
Perognathus penicillatus penicillatus: min.
Sylvilagus auduboni arizonae: min.
Felis oregonensis browni: min. (?)
Lynx eremicus eremicus: max. (?)
Mephitis estor: max.
Myotis californicus pallidus: min.

Remarks upon the Mesquite Association.—This association is given the vernacular name of what is perhaps the most widely known plant of the region, the mesquite (*Prosopis juliflora*). Along the Colorado River the mesquite is closely restricted to a rather narrow belt along the outer edge of the riparian area, mostly above the reach of the highest flood water. This belt is of course lacking where hills closely abut upon the river, save at the mouths of ravines. Along the great valleys it forms a nearly continuous tract consisting of straggling clumps or of well-formed, though small, trees, in the latter case sometimes orchard-like in regularity of spacing. At no point did we see mesquites with trunks over eight inches in diameter.

While evidently requiring abundant water at root, submergence of the ground for any length of time kills mesquites, as proven by

the conditions above the Laguna Dam. Here the whole association had been effaced by drowning. On the other hand, the mesquite is unable to exist on the desert proper, even in the larger washes. Only at the mouths of these did scattering examples extend away from the actual river bottom, and then, in the most favored places, for not more than a quarter of a mile.

Man's occupancy of the region has affected the mesquite association more than any other. The great value of the mesquite trunks for fuel has led to its practical disappearance as a tree along much of the lower course of the river. The steamboats which once plied regularly between Needles and Yuma are said to be chiefly responsible for this depletion. Several pumping plants contributed to the demand for fuel. Mesquite trees are very slow of growth; tracts of stumps now mark many areas where luxuriant groves once stood.

A considerable number of low-growing plants find places as elements in the mesquite association, but by far the most important to the animal life is the mesquite itself. This shrub, or tree, provides both shelter and food, the latter through its fruit and foliage (see pl. 6, fig. 7) either directly or by way of insects. The mesquite serves also as the host of a parasitic plant (pl. 6, fig. 6), a species of mistletoe (*Phoradendron californicum*), which when in blossom is visited by myriads of insects, and which produces an abundant and almost continuous crop of berries. Several of the winter and resident birds of the mesquite association depend almost wholly on these mistletoe berries for their food. Notable among these are: *Phainopepla*, *Mimus*, *Oreoscoptes*, *Planesticus* and *Sialia*.

Four species of breeding birds (*Pipilo aberti*, *Toxostoma crissale*, *Vermivora luciae*, and *Phainopepla nitens*) find in the mesquite association the center of their abundance. One mammal is characteristic of the same association, namely *Neotoma albigula venusta*.

Saltbush Association

BIRDS

Lophortyx gambeli: min.; resident
Zenaidura macroura marginella: max.; winter
Geococcyx californianus: min.; resident
Phalaenoptilus nuttalli nuttalli: min.; winter
Phalaenoptilus nuttalli nitidus: min.; resident (?)
Chordeiles acutipennis texensis: min.; summer (only as a forager)
Sturnella neglecta: excl.; winter
Poœcetes gramineus confinis: excl.; winter

Passerculus sandwichensis nevadensis: excl.; winter
Passerculus sandwichensis alaudinus: excl.; winter
Zonotrichia leucophrys gambeli: min.; winter
Spizella breweri: max.; winter
Amphispiza bilineata deserticola: min.; summer
Amphispiza nevadensis nevadensis: max.; winter
Lanius ludovicianus excubitorides: min.; resident (?)
Thryomanes bewicki eremophilus: min.; winter

MAMMALS

Citellus tereticaudus tereticaudus: max.
Peromyscus eremicus eremicus: max:
Thomomys albatus: excl.
Dipodomys deserti deserti: max.
Dipodomys merriami merriami: min.
Perognathus penicillatus penicillatus: min.
Lepus californicus deserticola: min.
Sylvilagus auduboni arizonae: min.
Taxidea taxus berlandieri: excl. (?)
Myotis californicus pallidus: Max. (?)
Pipistrellus hesperus hesperus: min.

Remarks upon the Saltbush Association.—Ranchers in the Colorado River region distinguish two portions in each of the valleys, the "first bottom" and "second bottom." These are of course duplicated in reverse position on opposite sides of the river. The first bottom is the overflow area, and comprises all the associations treated up to this point in the present chapter, from the river to the mesquite association, inclusive. These associations together constitute the riparian belt proper. The second bottom is in the nature of a terrace or bench, and is situated above the reach of high water, extending from the mesquite association desertwards to the base of the mesa bluff.

This second bottom is usually quite level and varies from a mere strip, of few yards in width, to a tract as much as a mile wide. It is for the most part clothed sparsely with xerophytic or halophytic vegetation, a predominating species in which is the saltbush (*Atriplex polycarpa*); hence the name adopted for the association represented.

The soil is almost always of fine sand, often wind-blown. The prevailing westerly winds have caused a growth of sand-dunes on the southeast edges of the second bottom at several points, notably on the Arizona side above Mellen. The driving sand is often arrested about a bush and as the resulting dune grows, so does the bush commensurately. A scrubby form of mesquite may thus constitute the core of a sand-dune. Several small plants are peculiar to these wind-formed hillocks, one of which is the sand verbena (*Abronia villosa*).

Favorable conditions for burrowing here attract heteromyid rodents, notably the large *Dipodomys deserti*. A characteristic assemblage results which might be appropriately called the aeolian sand association. Its peculiarities are not, however, in the writer's mind, sufficient to warrant giving it more than minor recognition. Future finer analysis may possibly justify the separate recognition of the aeolian sand association, especially when the reptiles of the desert at large are taken into consideration.

Elsewhere on the second bottom, depressions frequently occur where rainwater from adjacent desert slopes leaves by evaporation more or less alkali. In cases of excessive deposition, bare white stretches result, without any vegetation at all. On somewhat less alkaline ground there may be tracts of *Spirostachys occidentalis* and *Suaeda suffrutescens*, both being shrubby plants popularly included under the names pickle-weed and iceplant.

But the greater portion of the second bottom, as also a strip leading back along either side of the desert washes, is marked by the saltbush. This *Atriplex* is quite uniform in appearance wherever it grows, forming small but stout-branched bushes seldom more than two feet tall.

The creosote bush (*Larrea divaricata*), although predominating in the next-described association, occurs not infrequently as a minor element in the saltbush association. Sometimes individual plants of *Larrea* reach a very large size (pl. 7, fig. 8), much larger even than on the desert mesa. Where small alluvial fans from the higher adjacent mesa make down on to the second bottom, there is an influx of such plants as the coyote melon (*Cucurbita palmata*), rattle-weed (*Eriogonum inflatum*), unicorn plant, locally called devil's-claw (*Martynia proboscidea*), and sandbur (*Franseria dumosa*), all of which occur on sandy parts of the upper mesa as well. Along shallow washes through the second bottom there are often extensive thickets of *Lycium andersoni*.

In spite of the above indicated variations in floral constitution, there is remarkable homogeneity in the animal life of the saltbush association. In winter it is the preferred forage ground for a number of xerophilous fringillids, as shown in the accompanying list of birds. The generally loose, sandy soil seems to be an attractive feature for burrowing rodents of limited fossorial powers such as *Dipodomys merriami merriami*. These also find abundant food in the residual seeds of numerous small annual plants which for brief periods thrive on

the open ground between the shrubs. One such plant, gathered extensively by *Dipodomys deserti*, is *Achyronychia cooperi*.

It will be noted that the food-relations of the birds and mammals of the saltbush association and of the willow association are quite the reverse of one another; in the latter, *insectivorous* species prevail, in the former *graminivorous* or *spermophilous*.

Creosote Association (Mesa)

BIRDS

Chordeiles acutipennis texensis: max.; summer
Sayornis sayus sayus: min.; winter
Spizella breweri: min.; winter
Amphispiza bilineata deserticola: max.; summer
Amphispiza nevadensis nevadensis: min.; winter
Piranga ludoviciana: min.; transient
Salpinctes obsoletus obsoletus: min.; winter

MAMMALS

Ammospermophilus harrisi harrisi: min. (stony)
Ammospermophilus leucurus leucurus: min. (stony)
Citellus tereticaudus tereticaudus: min. (sandy)
Peromyscus eremicus eremicus: min. (sandy)
Thomomys chrysonotus: excl.
Dipodomys deserti deserti: min. (sandy)
Dipodomys merriami merriami: max.
Perognathus bombycinus: excl. (sandy)
Perognathus formosus: min. (stony)
Perognathus penicillatus penicillatus: min. (sandy)
Perognathus intermedius: min. (stony)
Perognathus spinatus spinatus: min. (stony)
Lepus californicus deserticola: max.
Canis ochropus estor: max. (foraged at night practically everywhere else)
Vulpes macrotis arsipus: excl.
Myotis velifer: max. (?)
Eptesicus fuscus: max. (?)
Macrotus californicus: max. (?)

Remarks upon the Creosote Association (Mesa).—The creosote bush (*Larrea divaricata*) was found to be the most widely distributed shrubby species of all the desert plants (see pl. 10, fig. 14). It occurred in varying abundance from the second bottom and wash-sides to the tops of the highest hills. Only the most rocky hill slopes, and the periodically eroded wash-bottoms, lacked this plant altogether. Yet there were obviously preferred areas of growth, or, still more notable in this connection, areas where the creosote bush grew to the entire exclusion of all other ligneous vegetation. These areas, where

Larrea was at least the most conspicuous plant, occurred mostly on the more level upland desert mesa. The accompanying distinctive assemblage of mammals justifies the recognition of what may therefore be appropriately called a creosote (or mesa) association.

Tongues of typical creosote association often run up from alluvial slopes into the rough hill country, following ravines and terraces. On the other hand, as already noted, the creosote bush and some of its companions in places invade the saltbush association. Along desert washes the two associations may be blended in all particulars to such an extent that definite diagnosis as one or the other is difficult.

As will have been observed from the lists, there are only two breeding birds of the creosote association proper, *Chordeiles acutipennis texensis* and *Amphispiza bilineata deserticola;* and neither of these are abundantly represented. But graminivorous mammals are plentiful in species as well as individuals. Not all the species, however, are found in exactly the same places. As elsewhere shown, identical ground on opposite sides of the river may possess distinct species because of the action of the river as a barrier.

Furthermore, segregation of rodent population on the basis of ability to find or dig safe retreats is evident. The nature of the ground thus bears a controlling relationship. Parts of the desert mesa are swept clean of fine sand by the prevalent winds, the resulting surface consisting of packed gravel, or wind-worn pebbles (pl. 12, fig. 18). Other parts of the desert have a sandy soil; and in places accumulations of sand transported by the wind have grown into sand-dunes, having much the character of those described for the saltbush association on a previous page.

On sandy ground a common small shrub was the sandbur (*Franseria dumosa*); the rattle-weed (*Eriogonum inflatum*) was ever summoning startled attention; and in the vicinity of Pilot Knob a species of *Ephedra* was common. On stony ground often no other plant was to be seen than the creosote bush; but everywhere remains of short-lived sporadic vegetation gave clue to the source of supply of the seeds upon which depended the rodent population. In the vicinity of Potholes and Pilot Knob the mesa association included scattering clumps of round-stemmed cactus, and ocotilla (*Fouquieria*).

Each of the two physical types of ground here noted, namely, sandy and stony, possesses certain peculiar species of mammals, as well as of plants. This segregation is indicated in the list, and might again serve as basis for recognizing two separate associations, the

sandy creosote, and the stony, or rocky, creosote; but by giving weight to *similarities*, as well as to differences, such distinction could be of but minor rank. Expediency seems to argue against further refinement in the present stage of study. Then, too, no such precise statistical gathering of data as regards the animals has yet been done as would warrant the exercise of such fine analysis.

Catclaw (or wash) Association

BIRDS

Lophortyx gambeli: min.; resident
Zenaidura macroura marginella: min.; winter
Bubo virginianus pallescens: max.; resident
Geococcyx californianus: max.; resident
Dryobates scalaris cactophilus: min.; resident
Phalaenoptilus nuttalli nuttalli: min.; winter
Phalaenoptilus nuttalli nitidus: min.; resident
Archilochus alexandri: min.; summer
Calypte costae: min.; summer
Myiarchus cinerascens cinerascens: min.; summer
Icterus cucullatus nelsoni: min.; transient
Icterus bullocki: min.; transient
Carpodacus mexicanus frontalis: max.; resident
Astragalinus psaltria hesperophilus: max.; resident
Zonotrichia leucophrys leucophrys: max.; transient
Zonotrichia leucophrys gambeli: min.; winter
Zamelodia melanocephala melanocephala: min.; transient
Phainopepla nitens: min.; resident
Lanius ludovicianus excubitorides: max.; resident (?)
Lanivireo solitarius cassini: min.; transient
Oreoscoptes montanus: min.; winter
Mimus polyglottos leucopterus: min.; winter
Heleodytes brunneicapillus couesi: max.; resident
Thryomanes bewicki eremophilus: max.; winter
Auriparus flaviceps flaviceps: max.; resident
Polioptila caerulea obscura: max.; winter
Polioptila plumbea: max.; resident

MAMMALS

Odocoileus hemionus eremicus: max.
Peromyscus eremicus eremicus: min.
Dipodomys merriami merriami: min.
Perognathus formosus: min.
Perognathus penicillatus penicillatus: max.
Perognathus spinatus spinatus: min.
Lepus californicus deserticola: min.
Lynx eremicus eremicus: min.
Urocyon cinereoargenteus scotti: min.
Pipistrellus hesperus hesperus: min.

Remarks upon the Catclaw (or Wash) Association.—Except for the Bill Williams and Gila rivers the Needles-to-Yuma section of the Colorado River receives no tributary stream, save as an immediate

result of the very infrequent local cloud-bursts or severe thunderstorms. Even the two "rivers" named often go completely dry in their lower courses following protracted drouth. At frequent intervals along the valley of the Colorado, well-defined but ordinarily dry water-courses leading down from the adjacent uplands record the existence at some time or other of considerable run-off. Among the hills, deep, steep-sided ravines show the profound effects of erosion, even though, in this era, rains come but rarely. Where the water-course drains a large extent of higher country, enough to furnish a volume of water sufficient to find its way through the mesa to the river, it may occupy a broad valley with low confining banks or bluffs. Such a broad, dry flood plain is called locally a "wash"; and as the biota of such "washes" is quite distinctive the term "wash association" has been suggested (see pl. 7, fig. 9). Since a prevalent plant in its flora is the tenaciously thorny catclaw (*Acacia greggii*), the term catclaw association may be used as an alternative denomination. Both are appropriate terms.

The vegetation of the catclaw association is the most conspicuous of all of the desert associations, for it includes several species which reach the stature of trees. The largest of these is the desert ironwood (*Olneya tesota*) which grows abundantly in all the larger washes on both sides of the river, from the lower Chemehuevis Valley at least to the vicinity of Picacho (pl. 8, fig. 10). The branches are leafy but thorny, forming ideal refuges for certain small birds and locations for their nests. The apparently leafless palo verde (*Parkinsonia torreyana*) is a close companion of the ironwood, and occurs also along the smaller ravines into the hills (see pl. 8, fig. 11; pl. 9, fig. 12). Both the catclaw and the palo verde were found in practically every wash on both sides of the river, from the vicinity of Needles to Pilot Knob. The smoke-bush (*Dalea spinosa*) is a conspicuous element in many of the washes from near Riverside Mountain to Pilot Knob.

As an indication of the size reached by individuals of these truly xerophilous trees the following measurements taken by the writer, are here presented: An ironwood growing in a wash about one-half mile back from the river bottom in lower Chemehuevis Valley, California side of the river, was 90 inches in circumference of trunk two feet above the ground, and had a height of 31 feet. A palo verde nearby was 48 inches in circumference of trunk two feet above the ground, and was 28 feet in height. Another palo verde (pl. 9, fig. 12) growing in a wash on Californian territory four miles north of Pot-

holes, was 60 inches in circumference of trunk two feet above the ground, first branch four feet above the ground, and total height 24 feet.

It is thus apparent that birds of arboreal habit find only in the wash association of the desert a near approach to conditions preferred elsewhere, and this doubtless accounts for the conspicuous transient arboreal element occurring in this association. But the greatly reduced foliage, giving most of the above-named trees the aspect of winter leaflessness, results in close resemblance to brush or shrubbery, as indicated by the prevalence of the brush-inhabiting category of breeding birds affecting them.

The ironwood occasionally harbors clumps of mistletoe (*Phoradendron californicum*) in common with the mesquite of the riparian belt. This accounts for the presence of certain berry-eaters. There are also berry-producing shrubs bordering the washes, notably *Lycium andersoni* and *Lycium parishi*. The former occurs widely as a characteristic member of the catclaw association. The latter, a much larger thicket-forming shrub, was noted only in small washes in the vicinity of Picacho. As already noted, *Atriplex polycarpa* occurs in an extension of the saltbush association leading up along each side of nearly all of the larger washes.

Bird-life is better represented in the catclaw association than in any other of the desert associations. Some of the species are closely adherent to it, being evidently by structure and habits dependent upon the conditions pertaining to thorny brush. But mammals are relatively less numerous. Only one rodent finds its maximum abundance along the washes (*Perognathus penicillatus penicillatus*, see fig. D), and it is possible that even of this species, the metropolis is in the adjacent sandy saltbush tract, and that trapping really waylaid the individuals foraging at large away from their homing places. Times of deluge, even if of rare occurrence, are doubtless accompanied by great mortality of ground-dwelling mammals along these washes. This factor must be one of no small import in determining the biotic constitution on the several levels of the desert surface.

Saguaro Association

BIRDS

Falco sparverius phalaena: max.; resident
Otus asio gilmani: min.; resident
Micropallas whitneyi: exel.; resident
Centrurus uropygialis: max.; resident
Colaptes chrysoides mearnsi: max.; resident
Myiarchus cinerascens cinerascens: max.; summer
Carpodacus mexicanus frontalis: min.; resident

MAMMALS

(As far as known, same as in creosote association.)

Remarks upon the Saguaro Association.—The conspicuous columns of the giant cactus or saguaro (*Cereus giganteus*) first met our expectant gaze just below the mouth of Bill Williams River. There, on both sides of the Colorado, for a stretch of two miles or more, stood many specimens growing on the hill slopes in full view from the river as we floated by. A landing was made on the California shore, and several saguaros closely examined for nesting sites of birds. We next found these cactuses on the open desert one to three miles east of the river on Arizona territory around Ehrenberg. There were so many here that they formed a distinct tract, extending across the mesas and occupying the interlying washes as well.

Giant cactuses again came to view some ten miles below Picacho, two or three individuals being seen on the California side and many on the Arizona side. Finally, on the mesa on both sides of the river, three to five miles above the Laguna dam, saguaros were plentiful. On the California side from one hundred yards to two miles back from the outer edge of the river bottom were about seventy-five individuals (see pl. 9, figs. 12, 13). Thirty-seven, big and little, were counted by the writer as in sight from one point.

It was gratifying thus to find this unique plant well represented on California ground. For coming with it into the state of California were the several birds listed, an assemblage altogether justifying the designation of a saguaro association. This association is best developed in a large area of southwestern Arizona. The tongue crossing the Colorado River above Laguna and Potholes is undoubtedly an extension of it.

As far as we were able to learn, in other plant elements and in mammals, the saguaro association was here identical with the creosote

association. It is not improbable, however, that further work would disclose the presence of a number of species of both mammals and birds, at least on the Arizona side, not now known so far west.

It is clearly apparent that the critical feature of the saguaro which prescribes its avian dependents is nothing else than the favorable opportunity offered for the excavation of safe retreats in its trunk. And only the two woodpeckers are equipped for making these excavations. So that, without the woodpeckers to make holes, the other birds would be no better off for the presence of the saguaro. As it happens, at least one of the species of woodpeckers (*Centurus uropygialis*) invariably accompanies the cactus.

This is a most interesting form of contingent or incidental interdependence of animal and plant. Since the giant cactus during the greater part of the year produces no fruit and harbors no insect life, it follows that all the birds using its cavities as roosting or nesting places glean their livelihood from the surrounding desert. The latter, as already stated, presents conditions which seem to be practically identical with the creosote association, which is so nearly barren of bird life, and of vast extent beyond the limits of the saguaro. One form of associational restriction is hereby proven, namely, that by dependence upon safe home retreats.

Encelia (Rocky Hills) Association

BIRDS

Buteo borealis calurus: max.; resident
Falco mexicanus: excl.; resident
Bubo virginianus pallescens: min.; resident
Aëronautes melanoleucus: excl.; resident
Calypte costae: max.; summer
Sayornis sayus sayus: max.; resident
Corvus corax sinuatus: min.; resident
Carpodacus mexicanus frontalis: min.; resident
Astragalinus psaltria hesperophilus: min.; resident (?) (as a forager only)
Spizella passerina arizonae: max.; winter
Spizella breweri: min.; winter
Spizella atrogularis: excl.; transient
Amphispiza bilineata deserticola: min.; summer
Stelgidopteryx serripennis: max.; summer
Salpinctes obsoletus obsoletus: max.; resident
Catherpes mexicanus conspersus: excl.; resident (?)

MAMMALS

Ovis canadensis nelsoni: excl.
Ammospermophilus harrisi harrisi: max.
Ammospermophilus leucurus leucurus: max.
Peromyscus crinitus stephensi: excl.

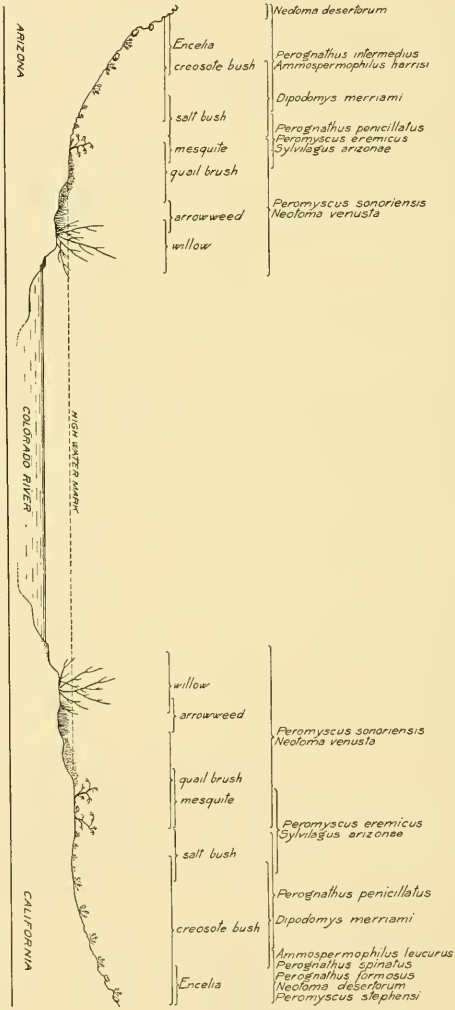
Neotoma intermedia desertorum: excl.
Perognathus formosus: max.
Perognathus intermedius: max.
Perognathus spinatus spinatus: max.
Corynorhinus macrotis pallescens: excl. (?)
Pipistrellus hesperus hesperus: max. (foraging everywhere else)

Remarks upon the Encelia (Rocky Hills) Association.—None of the hills or "mountains" in the near vicinity of the lower Colorado River is of such great altitude as to bring a reduction in temperature to an extent sufficient to modify its biotic complexion. The tallest of The Needles rises to less than 2,000 feet above the level of the river. In other words, as far as observed, the plants and animals of the hills show no distributional behavior other than as explained on associational grounds.

But the hill country does exhibit a distinctive association of plants and animals, setting them apart sharply from the desert mesa, or the riverside. A conspicuous shrub on the rocky steeps, especially at The Needles, was the dense *Encelia farinosa*, with its light gray foliage, growing on talus slopes and even in crevices of the cliffs (pl. 10, fig. 15). Other plants of the same locality were: *Atriplex confertifolia*, *Larrea divaricata* (sparsely intermixed), *Asclepias subulata* (visited regularly by the Costa hummingbird), *Fagonia californica* (on the hottest slopes of broken rock), *Hyptis emoryi* (a "sage-bush" five to six feet high growing on the sides of ravines and at time of blossoming, in March, frequented by hummingbirds), *Perityle emoryi* (an abundant composite annual, the seeds of which were much sought after in March by fringillids), and *Muhlenbergia debilis* (a grass growing in shaded ravines and providing forage for graminivorous rodents, like *Perognathus*).

While to distant view the hills seemed more barren of vegetation than most of the other associational areas, nearby inspection showed abundant remains of inconspicuous annual plants. This in part would seem to account for the great numbers of mammals present, as shown by our trapping. The additional favorable factor was evidently the abundance and availability of natural retreats afforded in the talus and fractured outcrops.

With insectivorous and raptorial species, such as the swifts and bats, hawks and owls, the rocky hills served merely as home retreats, foraging being doubtless carried to the more productive lowlands.



Ideal sectional Profile of Colorado River Valley at The Needles showing Plant and Mammal Associations

Fig. A

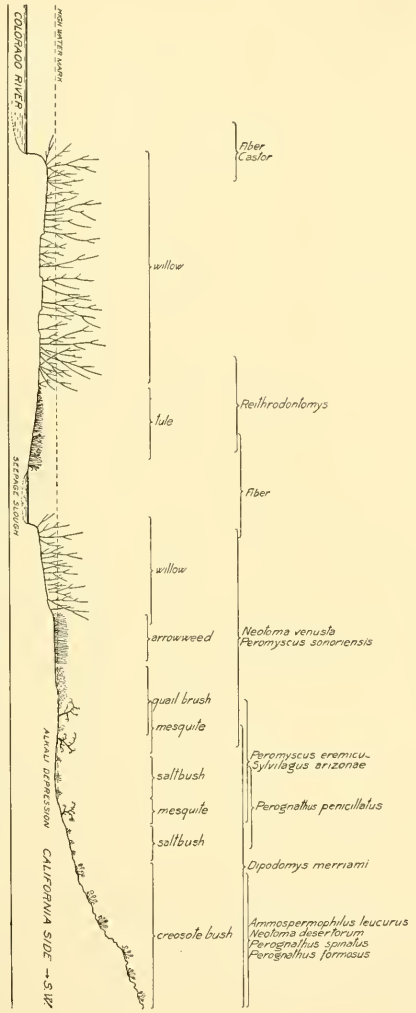


Fig. B

Ideal sectional Profile of Colorado River Valley eight miles east of Picacho showing *Plant and Mammal Associations*

NOTE.—The name *Fiber* used on this diagram equals *Ondatra* of the text.

particularly along the river bottom. Only two insectivorous birds were restricted to the Encelia-association, namely, the wrens, *Salpinctes obsoletus obsoletus* and *Catherpes mexicanus conspersus*. Both are by structure adapted to gleaning from crevices of rock surfaces after the manner of nuthatches on tree trunks.

General Discussion of Associational Restriction

From the preceding description of the conditions in the region studied, it is obvious that there are two groupings into which all the designated associations can be classed, namely, riparian and desert. The riparian set of associations includes those which owe their presence to the existence of the river, and is delimited outwardly at the mesquite association (see figs. A and B). The Colorado River apparently exerts no influence beyond the immediate bottom lands, which are affected by the underground water supply. All of the desert set of associations are represented in varying proportion over the vast arid tracts stretching away to the east and west of the river. Often they are discontinuous, but recur again and again in the same fauna with the same constitution.

The riparian associations are thus narrow strips of varying width closely paralleling the river from north to south and persisting practically continuously from the point of emergence of the Colorado River from the Grand Cañon to the Gulf of California. In the broad delta region the riparian associations spread out so that there are great areas of each, doubtless sufficient to be computed by the square mile. It is thus possible to trace the elements severally, of each association, to places of prevalence over considerable areas, even though those elements are, on the upper river, scattered sparsely along a narrow strip. Associational diagnosis of species thus often becomes possible when a knowledge of local conditions alone would be inconclusive. This principle deserves enlarging upon.

There were caught in the same trap-line opposite The Needles both *Peromyscus eremicus eremicus* and *Peromyscus crinitus stephensi*. It might have been impossible to say from the data gathered at that particular point, where the adjacent associations were complexly intermixed, just what sort of ground each species preferred. But trapping previously done in the salt-bush association in the Imperial Valley

showed the presence there of *P. c. eremicus* only, while field-work among the rocky hills in the vicinity of Victorville, on the Mohave Desert, showed *P. c. stephensi* only.

As another illustration, along the Colorado River, *Melospiza melodia saltonis* and *Pipilo aberti* were often found on common ground, although evidently averaging differently in associational preference. To prove beyond doubt what is the true ecologic niche of each, a knowledge of the distribution of each species elsewhere in their respective ranges becomes necessary. In the extensive arrowweed tracts around the west end of Salton Sea, *Melospiza melodia saltonis* is an abundant species while the other bird is absent. In the mesquite belt not far distant to the west, in the vicinity of Martinez and Torres, *Pipilo aberti* is prevalent, and the song sparrow absent. Hence the species of towhee in question may be confidently assigned to the mesquite association, and the subspecies of song sparrow to the arrowweed association.

It is not to be inferred that *all* species behave in this clearcut fashion associationally, any more than that all do so zonally or faunally (see Grinnell and Swarth, 1913, p. 220). At the same time the writer feels fairly sure of adequate grounds for proposing a general law in this regard, namely, that where the faunist happens to meet with a heterogeneous assemblage of biotic elements, not subject to clear associational diagnosis in the restricted locality of first observation, assignment of the species each to a well-defined association becomes possible by tracing out their ranges severally into the adjacent areas.

A concurrent axiom is that if associational analysis is carried far enough, no two species of birds or mammals will be found to occupy precisely the same ecologic niche, though they may apparently do so where their respective associations are represented fragmentarily and in intermixture.

In determining the associational status of mammals we have to deal chiefly with elusive animals, of nocturnal habits, which are hidden away during the day for the most part beyond reach. Trapping is not an altogether certain index to association; for individuals may be caught repeatedly in a trap-line which may not happen to intersect at all the regular forage ground or breeding home of the species. Individuals forage far and wide beyond the limits of their home territory and at the close of the breeding season wander in similar fashion. Some species, including nearly all mammals except xerophilous rodents, regularly travel far for water.

Attention is here called to our records of the capture of pocket mice. An unexpectedly large number of species of the genus *Perognathus* was found to occur in the region traversed. As many as three species were taken in one night in traps placed close together. But by testing *many* localities and comparing the results we soon came to know where to expect each separate species. The diagrams herewith presented (figs. C–F) show in statistical form the associational preferences of four species of *Perognathus*. Providing the same number of trap-nights (counting one trap set one night as one "trap-night") was

Fig. C. Diagram showing frequency of capture of *Perognathus formosus* in the several associations. There were fifty-three individuals trapped, of which the associational occurrence was satisfactorily recorded.

devoted to each association, this method should be fairly accurate. There will here occur to the reader ways of securing much greater precision in results of field-work in the future. But in fact, as our experience grew, far more effort was expended on ground promising additional specimens of rare species, than on ground already thoroughly exploited.

While a mammal or bird may be closely confined to a narrow territory characterized by certain conspicuous plants, the critical factor or factors of its environment may be quite apart from food requirements. As an illustration, the case of *Dipodomys deserti*

deserti may be cited. This rodent, taking its entire, irregular and discontinuous range into consideration, is closely restricted to those portions of the desert affording a deep surface layer of fine sand. Areas of acolian sands constitute its typical home territory (see pl. 11, fig. 16). Now, it is quite probably not any peculiarity of food-supply

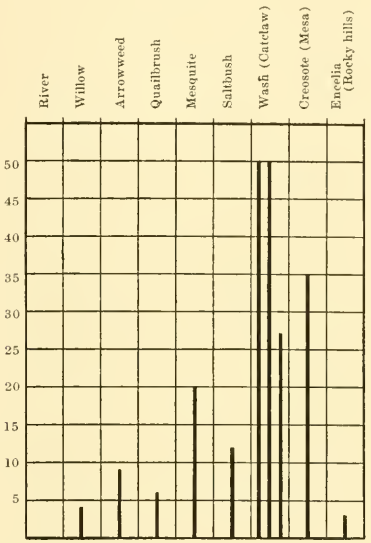


Fig. D. Diagram showing frequency of capture of *Perognathus p. penicillatus* in the several associations. Two hundred and seventeen individuals were taken, of which associational occurrence was definitely recorded. This species is seen to be very widely distributed, yet exhibiting marked preference for certain associations.

attaching to the aeolian sands, which binds the animal to them in this case rather than to the mesa at large; but it is the animal's requirements in the way of retreats for diurnal safety and for breeding. These, by nature of its fossorial limitations, *Dipodomys d. deserti* is unable to construct for itself except in ground easy to burrow into to a depth commensurate with its own large size and in soil with a proper degree of coherence.

In the case of desert quail there is a double need: of daily access to water, plus that for refuges constantly within easy reach in event of the birds being suddenly threatened by an enemy. The quail-brush association affords the ideal shelter. The futile efforts of a coyote or fox to dash in pursuit into such an interlacing thorny branch-work as is afforded by *Atriplex lentiformis* can be imagined!

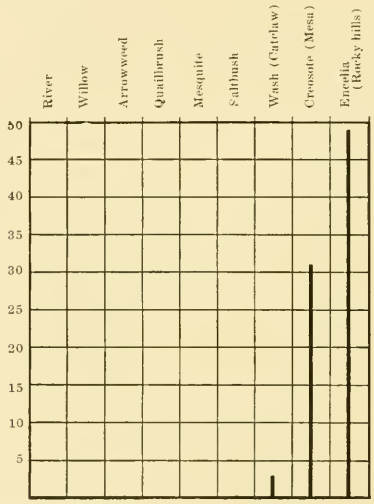


Fig. E. Diagram showing frequency of capture of *Perognathus intermedius* in the several associations. Eighty-three individuals were trapped, of which associational occurrence was definitely recorded.

In these cases and all others it is self-evident that presence of food-supply is the primal associational requisite, whatever other factors may be also essential. And kinds of food produced, with *regard to the structural characters* of each animal, determine what kinds of associational elements can exist in a locality. An animal having a specialized means of procuring food, like that of a sandpiper, or a woodpecker, or a rock wren, is hemmed in by the bounds outlining the

area in which it is able to get the food necessary for itself by the method which its anatomical structure and psychological equipment prescribe.

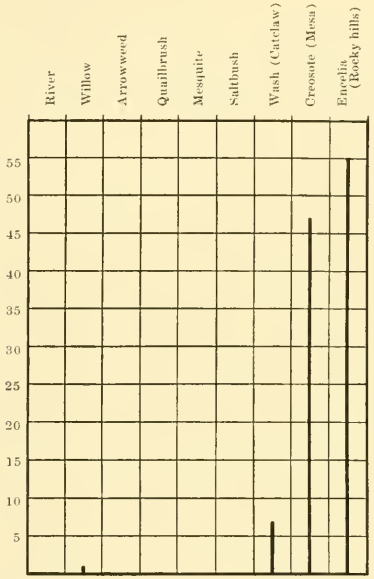


Fig. F. Diagram showing frequency of captnre of *Perognathus s. spinatus* in the several associations. One hundred and ten individuals were trapped, of which associational occurrence was satisfactorily recorded. While the associational preference of this species is almost identical with that of *P. intermedius,* the ranges of the two species are wholly distinct, being separated by the Colorado River. Associational preference is also seen to be similar to that of *P. formosus,* which occupies apparently identical ground. But *P. spinatus* belongs to a different subgenus (*Chaetodipus*) from *P. formosus* (subgenus *Perognathus*), hence the two are not nearly related and probably do not come into close ecological competition.

Not infrequent are the cases where food-supply is located in one place, and the refuge or breeding site in another. Animals of such habit are necessarily of relatively great powers of locomotion, and may live regularly in two or more associations situated remotely from

one another. Incidentally all other associations may be crossed, back and forth. *Ardea herodias treganzai* foraged far and wide in the river association, but reared its young in restricted parts of the willow-cottonwood association where lofty trees provided safe nesting sites. *Aëronautes melanoleucus* found safe rendezvous in crevices of cliffs, but foraged far over the lowlands; so also with certain bats. The relations between animals and their environments are manifold and complicated; and these interrelations depend both upon the inherent peculiarities of the entire organism in the case of the animal and upon the physical nature of the environment.

After a consideration of all the birds and mammals mentioned in the present report, as occurring both in the region specifically treated and elsewhere as far as the writer's knowledge goes, associational restriction appears to be governed by the following three factors, of relative importance in the order named.

1. Kind of food-supply afforded, with regard to the inherent structural powers of each of the animals concerned to make it available.

2. Presence of safe breeding-places, adapted to the varying needs of the animals, in other words, depending upon the respective inherent powers of construction, defence and concealment in each species concerned.

3. Presence of places of temporary refuge for individuals, during day time or night time, or while foraging, when hard pressed by predatory enemies, again correlated with the respective inherent powers of defence and concealment of each species involved.

THE COLORADO RIVER AS A HIGHWAY OF DISPERSAL AND CENTER OF DIFFERENTIATION OF SPECIES

According to Gilbert and Scofield (1898, pp. 487, 488) the peculiarities of the fish fauna of the Colorado River bespeak a very long period of absolute isolation. A remarkably high percentage of its fishes are specifically distinct from those of the other river basins of western North America. The same is to be said of the riparian birds and mammals.

So far as known to the present writer, none of the species listed with a star in the following table ranges beyond the confines of the Colorado River basin, including of course its various tributaries and distributaries such as the Gila and New rivers, except sporadically, or as accounted for by distal invasion through passes or along sea-coastal tracts. In other words, the Colorado River has been in existence so long that the conditions imposed by its presence have figured in the differentiation of representative species of several families, both mammalian and avian.

The great age of the Colorado River is indicated geologically by the vast extent and slow rate of the erosion involved in the formation of the Grand Cañon. This time-element is justly inferred to have been an essential condition in the formation of these species.

Species which Belong to the Riparian Belt, and which are Therefore Hemmed in by the Paralleling Desert Tracts. Starred Species are Peculiar to the Colorado Subfauna

BREEDING BIRDS	MAMMALS
Agelaius phoeniceus sonoriensis*	Castor canadensis frondator*
Melospiza melodia saltonis*	Peromyscus maniculatus sonoriensis
Pipilo aberti*	Sigmodon hispidus eremicus*
Guiraca caerulea lazula	Reithrodontomys megalotis deserti
Piranga rubra cooperi	Neotoma albigula venusta*
Vireo belli arizonae*	Ondatra zibethica pallida*
Vermivora luciae*	Mephitis estor
Dendroica aestiva sonorana*	Procyon pallidus*
Toxostoma crissale*	

It may not be amiss to consider these riparian species somewhat with regard to origin. By confining our attention to the north-and-south valley of the lower Colorado, this becomes, with a knowledge of the general status in North America of each group represented, a com-

paratively simple matter. The axiom holds, that, because of the ever-shifting location geographically of associational, faunal and zonal conditions, every single element or line of descent, now represented in the biota of any one locality must have come either in its present form or in some anteeedent one from somewhere else. This is certainly true of all terrestrial life. Elevation and depression have worked like a seesaw in dislocating faunas. The Colorado valley is a trough, hemmed in associationally on either side, and only capable of influx of riparian elements at either end. Therefore the riparian species of the Colorado fauna can have entered the area under consideration from only two directions: from the north and from the south.

Only two species are clearly seen to have entered the Colorado valley from the north: *Castor canadensis frondator*, and *Ondatra zibethica pallida*. The following species or subspecies are believed to have come in from the south: *Pipilo aberti, Guiraca caerulea lazula, Piranga rubra cooperi, Vireo belli arizonae, Vermivora luciae, Toxostoma crissale, Sigmodon hispidus eremicus, Neotoma albigula venusta.*

In the remaining seven cases (*Agelaius, Melospiza, Dendroica, Peromyscus, Reithrodontomys, Mephitis* and *Procyon*) no grounds are apparent to the writer for assigning either one over the other direction of invasion, and this in spite of whatever may be the marked Austral or Boreal distributional affinities of each group concerned. The tide of invasion may in fact in these species have tended in one direction at one period, in the opposite at another; or, as in *Peromyscus maniculatus sonoriensis*, the Colorado valley may have acted continuously as a narrow bridge where have met and mingled descent-lines from both the north and the south.

The obvious fact that southern representatives prevail over northern ones is clearly attributable to the present zonal condition obtaining in the region, namely Austral, in its Lower Sonoran division. And evidence elsewhere assembled (Grinnell and Swarth, 1913, p. 383) points towards an increasing temperature throughout the region. This would result in decreasing the favorableness to Boreal forms and increasing the availability of the region for immigration of Austral types. Consideration of the xerophilous vertebrates as well as of the riparian ones leaves little doubt in the writer's mind but that this has been the actual course of events. The northern contingent is on the wane, the southern in the ascendency.

The query presents itself: is the Colorado fauna *full?* Are all the ecological niches, which are available in this area and which have

occupants in other regions, occupied here? Probably not, for the intervention of barriers has doubtless prevented the invasion of types which, if they could have once gotten there, would have thriven and assumed a place as endemic elements in the fauna. Sporadic incursion, as of migrants among birds, and strays among both birds and mammals, do not appear to the writer to figure in such a process. Rather must it be a progressive invasion of the species *en masse*, acquiring, it may be, adaptive modifications as it proceeds. In other words, the conquering of the land is the combined result of the facilities offered by it plus the relative amenability of each species concerned.

The twelve riparian species and subspecies peculiar to the Colorado fauna vary much in degree of difference from their near relatives which occupy adjacent differentiation areas. These varying degrees of difference might be interpreted as measures of the periods of time elapsed since the entrance into the region of each of the types involved. That this conclusion is poorly grounded is evident upon consideration of the various other elements which must figure in the process of species formation. Among these may be suggested: degree of isolation, divergence of homologous associational conditions in the new region from those in the ancestral, and inherent susceptibility to adaptive modification in each of the species concerned.

In the problem of the origin of the riparian portion of the Colorado fauna we seem to have to do with an accentuated kind of isolation. For, as already asserted, there is such a thing as *more* and *less* isolation. In the region here considered, possessing extreme associational contrast, we find the ordinary geographic, or more properly speaking, physiographic, isolation coupled with associational isolation. In consequence of this extra favorable contingency, differentiation of species may have progressed with particular celerity, with such distinct forms to show for it as *Pipilo aberti*, *Vermivora luciae*, *Toxostoma crissale*, and *Procyon pallidus*.

The axiom has presented itself in this connection that the *more* restricted a species is associationally, that is, the more confined to a narrow range of associational conditions, the more subject it is to the important factor of isolation; hence the more liable to give rise to new incipient strains in different parts of its general range.

An assertion which seems at first glance opposed to the above is: that the *less* restricted a species is associationally, that is, the more *widely* adaptable to varying conditions, the more numerous the chances

for local operation of isolation, because more opportunity for radial dispersion to carry the species into distant localities and under extreme conditions, and for the ultimate interposition of more or less efficient barriers. The factor of distance might here replace the operation of associational restriction in segregating descent-line plexuses.

These are apparently incongruous notions, but the following conception tends to harmonize them; namely, that, granting the three totally different orders of distributionally limiting factors (zonal, faunal and associational), it is probable that different species are restricted *unevenly* with respect to the three; thus a certain wood-rat (*Neotoma intermedia desertorum*) is restricted faunally, but ranges widely through zones and associations; a certain wren (*Telmatodytes palustris* and subspecies) is tightly restricted associationally, but ranges widely through faunas and zones; a xerophilous genus of rodents (*Perognathus*) is closely restricted zonally and associationally, but ranges rather widely as to fauna. So that both the above assertions might well be true of a single animal historically and even, in different parts of its range, simultaneously! Certainly the first serves in explanation of the multiplicity of geographic races or species in several widespread groups of birds and mammals.

THE COLORADO RIVER AS A HINDRANCE TO THE DISPERSAL OF SPECIES

Bats and most birds find in the Colorado River no hindrance whatever to individual travel. Freedom of aerial locomotion gives them superiority over any obstruction on the general level of the country they inhabit. It is possible that in a few of the resident birds of limited flight individuals do not regularly cross the main stream, though they readily could do so if such an exigency as that of fire sweeping the bottom lands should drive them to it. *Geococcyx californianus*, *Pipilo aberti* and *Toxostoma crissale* are birds which probably do not often cross the river under normal circumstances.

Among mammals, carnivores are usually of much wider foraging range than rodents. From all the data available it appears that none of the carnivores, not even the cats, are averse to swimming the river if need be. Among rodents, however, our work showed a number of cases in which the Colorado River had effectively checked the distribution of species. The following tables show the situation as regards all the rodents of the region (see also figs. A, B).

RODENTS IN WHICH THE COLORADO RIVER ACTS AS AN ABSOLUTE BARRIER

Association	*Arizona side*		*California side*	*Association*
Encelia and Rocky Creosote	Ammospermophilus harrisi harrisi		Ammospermophilus leucurus leucurus	Encelia and Rocky Creosote
			Peromyscus crinitus stephensi	Encelia
Sandy Creosote	Thomomys chrysonotus	Colorado River		
			Thomomys albatus	Saltbush
			Perognathus formosus	Encelia and Rocky Creosote
Encelia and Rocky Creosote	Perognathus intermedius			
			Perognathus spinatus spinatus	Encelia and Rocky Creosote

RODENTS WHICH OCCUR ON BOTH SIDES OF THE COLORADO RIVER, BUT WHICH SHOW SLIGHT, ALMOST IMPALPABLE, DIFFERENCES ON THE TWO SIDES

	Association
Citellus tereticaudus tereticaudus	Sandy Creosote and Saltbush
Dipodomys deserti deserti	Sandy Creosote and Saltbush
Perognathus penicillatus penicillatus	Saltbush and Sandy Creosote

RODENTS WHICH ARE APPARENTLY IDENTICAL ON THE TWO SIDES OF THE COLORADO RIVER

	Association
Castor canadensis frondator	River
Peromyscus maniculatus sonoriensis	All Riparian
Peromyscus eremicus eremicus	Saltbush and Sandy Creosote
Sigmodon hispidus eremicus	Willow and Tule
Reithrodontomys megalotis deserti	Tule and Willow
Neotoma albigula venusta	Mesquite and other Riparian
Neotoma intermedia desertorum	Encelia
Ondatra zibethica pallida	River
Dipodomys merriami merriami	Saltbush and Sandy Creosote
Perognathus bombycinus	Sandy Creosote
Lepus californicus deserticola	Creosote and Saltbush
Sylvilagus audubonii arizonae	Quailbrush and Mesquite

The fact is apparent that only members of the strictly desert associations are stopped at the river. And of these the species of the *most remote associational position* are, with one exception, *Neotoma intermedia desertorum*, most effectively delimited. Also *degree of isolation* is in a measure commensurate with *amount of difference* between forms of the same genus.

It is pertinent to inquire *how* the Colorado River acts as a barrier to those species affected. It appears that in every one of the eleven cases the animal in question has no need to visit any water-supply. All are species capable of maintaining successful existence without a drop of water other than that obtained by chemical elaboration from their food. In our three months' experience we did not once find evidence that any individual of any of the eleven species in question had visited the river's edge.

Furthermore, to the best of our knowledge, all the species are of limited foraging range. In the case of the two diurnal chipmunks, *Ammospermophilus harrisi harrisi* and *Ammospermophilus leucurus leucurus*, which could be *seen*, it was seldom that an individual was come upon more than fifty yards from its burrow. In the case of *Perognathus*, which carefully closes the mouths of its burrows for the day, after its night's activity abroad, it was impossible to secure definite information on this score except as afforded by trapping; but the writer's impression is that it, too, does not ordinarily venture many rods from its retreat. Individuals doubtless travel farther at times of rutting, but it is likely that even then the limits of the native association would not be far transgressed.

It is further to be noted that those species finding an insuperable check at the river are all closely confined to one general kind of associational environment, even though two minor associations, as here defined, be occupied. The river *plus* intervening associations of an unfavorable nature constitutes the *total* barrier to the rodents in question.

It is true that the element of distance here implied is reduced to a negligible quantity where hills closely abut upon the river channel. But the major part of the river's course, probably four-fifths of it below the lower end of the Grand Cañon, is through valleys of varying width, occupied by riparian associations most adverse in essential ecological particulars to the species of the upland deserts adjacent.

Along the remaining fifth of the river's course, where the banks rise abruptly and are continuous with the adjacent hill slopes, with

either no trace of riparian tracts or only narrow or interrupted representations, it would seem that chance *is* afforded for such mammals as the desert chipmunks and pocket mice to encounter the river itself, with all intervening factors removed.

At our base camp (no. 4) at The Needles, our measurements showed the actual width of the stream to be 450 feet at the rather low stage of water obtaining at that time (March 4, 1910). At high water the river could not have been much more than 150 feet wider (see sectional profile, fig. A, and pl. 10, fig. 15). In the box cañon two to three miles below, the width of the river *appeared* to be much less, and, because of the precipitous walls, high water would make little change in width.

The two species of *Ammospermophilus* were *seen* at points only about 850 feet apart in a direct line. All the mammals of the Encelia association, as segregated here on the two sides of the river, were trapped at this station within one thousand feet of one another. The same situation obviously held at several other points along the Colorado River. The sharp separation of the ranges of nearly related vertebrates by a barrier of such narrow width is, to the best of the writer's knowledge, not known elsewhere in North America.

As to the opportunities for crossing the river by such individuals as might get to the water's edge, only speculation is now possible. At times of rising water, riparian mammals are undoubtedly often marooned upon islands and finally forced to swim or to take refuge on floating drift. Practically all the riparian species are known to be able to swim readily, and are probably in ways just mentioned frequently carried from side to side of the river.

The ability of typical desert animals to care for themselves if cast into the water is problematical, though a little experimentation would go far to proving the point one way or the other. Their powers in this line may be inferred to be limited because of the facilities normally lacking for putting such powers into practice. For instance, there is fair probability that a *Reithrodontomys* could safely cross a turbulent stretch of current, where a *Perognathus* would perish before any chance of reaching the shore.

Protracted observation along the river brings conviction to the observer that no animal of weak swimming powers is likely to survive many minutes of exposure to the main current. It is a fascinating diversion to watch the course of a stick or log adrift in the stream. Such an object pursues an exceedingly devious course.

It may be carried close under the steep outside bank of an ox-bow swing, only to be directly thrown back towards the opposite shore. Stretches of rough water may be encountered where the object is swamped at the crest of every wave. Or, along rocky parts of the channel, swirls, large and small, arrest its passage. In the most violent of these eddies a twenty-foot log was seen to up-end and sink from sight, to reappear after its total submergence, a hundred yards down stream.

At times of falling water a great deal of drift lodges on mudbars and projecting reefs of rock. It is imaginable that drift logs *might* be reached by individuals, which freed again with subsequently rising water, would carry their passengers until lodged under favoring circumstances on the opposite side of the river. In the account of *Neotoma intermedia desertorum*, the only rodent of the Encelia association not checked by the river, it is suggested that in some such way passage was secured from the California to the Arizona side of the river. This wood rat now bids fair to occupy much appropriate territory in southwestern Arizona not previously possessing an associational homologue, that is a Neotoman representative. *Neotoma* may be looked upon as a more hardy and ecologically less specialized rodent than any of its associational companions. It is certainly much the largest, and is notoriously of aggressive disposition as a forager.

Of the eight species of delimited rodents, not one individual of the hundreds trapped was found on the "wrong" side of the river. As far as they went, then, our efforts furnished no evidence that even an occasional individual does get across. As already shown, there seems to be nothing to attract the upland rodents to the water's edge, so that possibility of securing safe transportation on a log or mass of drift is doubly remote. Now, supposing that a single individual *did* manage to reach the opposite shore, its *species* would not necessarily be established there. In most cases (not, however, with *Peromyscus crinitus stephensi* and *Perognathus formosus*) there is already established an associational homologue, with which even a whole family of the invaders would have to compete, with the chances at least as much against success as favoring it. Hybridization might occur, granted that no sexual antipathy arise, but, whatever the immediate results, it is the impression of the writer that swamping would eventually be likely to wipe out all trace of the invading species. This impression is admittedly based upon fragmentary data which has not been subjected to critical analysis. Whether or not Mendelian behavior in

inheritance of characters obtains among the rodents here concerned is yet to be proven.

Suffice it to say that all the evidence at hand shows the Colorado River to have effectually blocked distribution, in the two directions concerned in the eight cases as listed. While this hindrance to distribution involves the species, it does so through its mechanical action upon the frontier *individuals* of each species. Hypothetically the invaders are severally hurled back or else destroyed outright.

The divergent characters displayed by the upland rodents of the two sides of the Colorado River are, in the mind of the writer, to be best explained on historical grounds. It is not necessary to believe that the specific characters concerned arose in the immediate vicinity of the river, though the circumstance of segregation alone is deemed by some to suffice as a cause of differentiation. The climatic features (zonal and faunal, as well as associational) are identical on the two sides of the river. Rather is it reasonable to presuppose separate and rather remote centers of differentiation, and convergent dispersal through time and space which brought the resulting types to the verge of the river, beyond which they were unable to spread.

It is possible that an arm of the sea continuous with the Gulf of California once extended northward into southern Nevada. A submergence of only 1,000 feet would divide the present desert areas of western Arizona and southern California into two peninsular land masses, which might have served as well-isolated centers of differentiation for various forms which later spread with the elevation of the land until their ranges abutted. Unfortunately for this suggestion, as I am informed by Professor John C. Merriam, geological evidence fails so far to show the existence of such conditions within Pleistocene or even Pliocene times. The suggested explanation must therefore be discarded in our dealing with the differentiation of present-day species and subspecies, especially since even the genera represented and as now restricted are not known to have evolved so early as Miocene.

But another process, recognizable far and wide in dynamic zoogeography, may be called into account without assuming any departure in the past from topographic and climatic conditions as they are today. Comparison of the fauna of the Lower Sonoran plains of south central Arizona with that of the Mohave desert plateau in the same zone, shows two prevalent character combinations among the nearly related component species. The mid-Arizona representatives are usually dark colored and large sized; the reverse appearing to hold in the majority

of the Mohave desert forms. There is considerable floral difference in the two regions, and minor climatic differences are well known. Different environments thus impinge upon the animals in these widely separated centers, and more or less regular blending of conditions occurs between. Although every factor of environment may be identical immediately on the two sides of the Colorado River, the animals now there have undoubtedly descended from ancestral lines which have invaded the territory from the two opposite directions, bringing with them by inheritance the characters developed under the two different sets of conditions.

To express the idea otherwise, from each differentiation area there is an outwardly radiating dispersal of descent-lines, involving time as well as space. This dispersive process is going on now as it has through past time. The eastward-flowing tide of Mohave forms would only be arrested by an insuperable barrier, such as the Colorado River. The westward invading descent-lines from the Arizona center would proceed until stopped by the same barrier. Both sets of forms would find themselves along the Colorado Valley under the same associational, faunal and zonal conditions; but each set is continually receiving by the process of inheritance plus invasion the peculiar characters generated on its own side.

While the Colorado River probably lies in an intermediate position between the Mohave and Arizona faunas, the area of intermediate conditions of environment is probably relatively narrow. This very element of narrowness may be called in to account for the lack of modification displayed by the delimited species of the Colorado River frontiers, for example, in the case of *Ammospermophilus*.

Supposing now that the Colorado River does not serve as an insuperable barrier, nor ever has done so; invasion would have extended from one side to the other as far as associational, faunal or zonal barriers permitted. In animals of wide distribution, intergradation geographically between the remote extremes would in the end be expected to occur. The extremes would not then have differentiated so far, at least in quantity of each character developed, because of inheritance from the opposite type, again involving time and space, concomitantly. Subspecies would have resulted, instead of full species. This condition doubtless obtains in some of the birds, as well as in some of the rodents listed as being the same on the two sides of the river. Take, as an example, *Dipodomys merriami merriami* of south central Arizona, and *Dipodomys merriami simiolus* of the Mohave

desert. Our Colorado River series is fairly intermediate between the extreme types, though the extremes are not so different as are *Ammospermophilus harrisi harrisi* and *Ammospermophilus leucurus leucurus*. As elsewhere explained, the river is believed to be not so much of a barrier to *Dipodomys merriami* as to the forms of *Ammospermophilus*.

The *degree of hindrance*, ranging from the condition, as in the case of *Castor* and *Ondatra*, where the river offers no bar to perfect freedom of crossing, to that where the river is an absolute barrier, as in the case of species of *Perognathus* and *Ammospermophilus*, accords so closely with *degree of difference* in characters developed on the two sides of the river, that adequate ground is afforded for the belief that intervention of barriers is a prime factor in the differentiation of species. And furthermore, it would appear that no two species, in birds and mammals, arise except through geographic segregation.

THE PROBLEM OF BARRIERS WITH REGARD TO BIRDS AND MAMMALS

The geographical range of any species of animal may be likened to a reservoir of water in a cañon. The confining walls are of varying nature. A concrete dam, absolutely impervious, may retain the water at one end. Along either side the basin's walls differ in consistency from place to place. The substratum varies in porosity, at some points impervious like the dam, at others permitting seepage of water to a greater or less distance from the main volume. The water continually presses against its basin walls, as if seeking to enlarge its area. And it may succeed in escaping, by seepage through such portions of its barrier as are pervious or soluble, or by free flow through a gap in the walls, if such offers. The area occupied by the water will extend itself most rapidly along the lines of least resistance.

Every species has a center or centers of abundance in which favoring conditions usually give rise to a rate of reproduction more than sufficient to keep the critical area stocked. A tendency to occupy a larger space results because of competition within the species, and individuals and descent-lines multiply and travel radially, extending those segments of the frontier where least resistance is offered. Such radial dispersal takes place slowly in some directions, more rapidly in others, according to the degree of passability of the opposing bar-

riers. These barriers consist of any sort of conditions less favorable to the existence of the species than those in the center of abundance.

Theoretically, sooner or later and in all directions, every species is absolutely stopped. But as a matter of undoubted fact most barriers are continually shifting, and the adaptability of the animals themselves may be also undergoing continual modification; so that perfect adjustment is beyond the limits of possibility so long as topography and climate keep changing. The ranges of species may thus be constantly shifting. Descent-lines may move about repeatedly over the same general region, like sparks in the soot on the back of a brick fireplace.

Yet, in all of our studies, of but a few years' duration, the time element is reduced almost to a negligible quantity, and we may look upon the areas occupied by each species as, for the time of our observation, fixed. We are thus enabled to compare one with another, and because of the large number of the species, we can infer a good deal as to the nature of barriers in general as regards birds and mammals. It is even conceivable that with sufficient refinement in methods the inquirer may in time find himself able, from a comparative study of the ranges of rodents, for example, to establish the identity of all of the external factors which have to do with the persistence of each species; in other words to analyze the "environmental complex" into its uttermost elements as regards the existing species of rodents in their recent development.

The most obvious kind of barrier to distribution is that consisting of any sort of physical, or mechanical, obstruction. Such obstruction affects directly the *individuals* of a species encountering it, either by stopping their advance, or by destroying outright such as attempt to cross it. As barriers of this nature are to be cited land to purely aquatic mammals, and bodies of water to purely terrestrial, especially xerophilous, mammals. In each case width of the barrier has to do with degree of impassability. Oceans and continents are most perfect and affect a large proportion of the species. The comparatively narrow Colorado River is a barrier of the first rank, but only to a certain few desert rodents, as pointed out in a preceding chapter. Mechanical barriers, where they exist at all, are clearly recognizable.

It is to be observed, however, upon considering the birds and mammals of a whole continent, that by far the greater numbers of species are delimited in range irrespective of any direct dependence upon actual land and water boundaries; more explicitly, their ranges fall

far short of coast lines. The barriers here concerned are intangible but nevertheless powerful. By their action the spread of species, genera, and families is held in check as surely as by any tangible obstruction.

By these invisible barriers the *individual* may not necessarily be stopped at all, as with animals of free locomotion; but the *species is* affected. For example, the mockingbird (*Mimus polyglottos leucopterus*) in its Californian distribution is closely confined to those parts of the state possessing certain definite climatic features; but vagrant individuals, especially in autumn, occur beyond the limits of these restrictive conditions. Carnivorous mammals are well known to be subject to sporadic wanderings on the part of individuals, but the *species* is kept in set bounds by some potent but invisible set of factors. The very fact that *individuals* are quite capable of temporarily transgressing these bounds and yet do not overstep them *en masse* emphasizes all the more the remarkable potency of this category of barriers as regards species and higher groups.

Our geographic studies lead us to designate among these relatively intangible barriers: (1) increase or decrease in prevailing temperature beyond certain critical limits, according to the species concerned; (2) increase or decrease in prevailing atmospheric humidity beyond certain limits; (3) modification in food-supply and appropriate breeding and foraging ground as regards the inherent structural equipment of each animal considered. In these three sorts of barriers will be recognized the *zonal*, *faunal* and *associational* delimitation as discussed in previous chapters.

CLASSIFICATION OF BARRIERS TO SPECIES AS REGARDS BIRDS AND MAMMALS

Barriers:

- A. Tangible (mechanical)
  - (*a*) Land to aquatic species
  - (*b*) Bodies or streams of water to terrestrial species
- B. Intangible (non-mechanical)
  - (*a*) Zonal (by temperature)
  - (*b*) Faunal (by atmospheric humidity)
  - (*c*) Associational
    - (1) By food-supply
    - (2) By breeding places
    - (3) By temporary refuges

      (Each of these three with regard to the inherent structural characters of each species concerned).

The above categories are believed to include all the factors commonly involved in the checking of the spread of species of birds and mammals. It is possible that inter-specific competition may sometimes occur where associational homologues meet. But even here it becomes a matter of relative associational fitness which determines supremacy and consequent ultimate limits of invasion of the forms concerned.

A mountain range is no barrier at all, *per se*, as frequently alleged. Only as it involves zonal or faunal barriers does it affect distribution. The same is true of a valley or a desert.

As far as contemplation of cases has gone, the writer's experience has led him to believe that the outlines of the ranges of all birds and mammals may be accounted for by one or more of the factors indicated in the above analysis. And as detailed knowledge of the facts of geographical distribution accumulates, the delimiting factors become more and more readily detectable. By such a study, of *comparative distribution*, it seems possible that the ranges of birds and mammals may become subject to satisfactory explanation. The instances included in the list of species discussed in the present paper, when considered in connection with many similar ones, point without exception towards the existence of the set of factors above specified as delimitors.

When considered in its historical bearing, the problem of barriers concerns itself intimately with the origin of species. It is believed by the writer that only through the agency of barriers is the *multiplication of species*, in birds and mammals, brought about.

CHECK-LIST OF THE BIRDS

1. Gavia immer (Brünnich)
2. Sterna forsteri Nuttall
3. Phalacrocorax auritus albociliatus Ridgway
4. Pelecanus erythrorhynchos Gmelin
5. Mergus serrator Linnaeus
6. Anas platyrhynchos Linnaeus
7. Nettion carolinense (Gmelin)
8. Querquedula cyanoptera (Vieillot)
9. Spatula clypeata (Linnaeus)
10. Dafila acuta (Linnaeus)
11. Marila affinis (Eyton)
12. Erismatura jamaicensis (Gmelin)
13. Chen hyperboreus hyperboreus (Pallas)
14. Plegadis guarauna (Linnaeus)
15. Mycteria americana Linnaeus

16. Ardea herodias treganzai Court
17. Herodias egretta (Gmelin)
18. Butorides virescens anthonyi (Mearns)
19. Nycticorax nycticorax naevius (Boddaert)
20. Grus canadensis (Linnaeus)
21. Recurvirostra americana Gmelin
22. Fulica americana Gmelin
23. Pisobia minutilla (Vieillot)
24. Actitis macularius (Linnaeus)
25. Oxyechus vociferus vociferus (Linnaeus)
26. Lophortyx gambeli Gambel
27. Zenaidura macroura marginella (Woodhouse)
28. Melopelia asiatica trudeani (Audubon)
29. Cathartes aura septentrionalis Wied
30. Circus hudsonius (Linnaeus)
31. Accipiter velox (Wilson)
32. Accipiter cooperi (Bonaparte)
33. Buteo borealis calurus Cassin
34. Falco mexicanus Schlegel
35. Falco columbarius richardsoni Ridgway
36. Falco sparverius phalaena (Lesson)
37. Pandion haliaëtus carolinensis (Gmelin)
38. Aluco pratincola (Bonaparte)
39. Otus asio gilmani Swarth
40. Bubo virginiänus pallescens Stone
41. Micropallas whitneyi (Cooper)
42. Geococcyx californianus (Lesson)
43. Ceryle alcyon (Linnaeus)
44. Dryobates scalaris cactophilus Oberholser
45. Sphyrapicus varius nuchalis Baird
46. Centurus uropygialis Baird
47. Colaptes cafer collaris Vigors
48. Colaptes chrysoides mearnsi Ridgway
49. Phalaenoptilus nuttalli nuttalli (Audubon)
50. Phalaenoptilus nuttalli nitidus Brewster
51. Chordeiles acutipennis texensis Lawrence
52. Chaetura vauxi (Townsend)
53. Aëronautes melanoleucus (Baird)
54. Archilochus alexandri (Bourcier & Mulsant)
55. Calypte costae (Bourcier)
56. Tyrannus verticalis Say
57. Myiarchus cinerascens cinerascens (Lawrence)
58. Sayornis sayus sayus (Bonaparte)
59. Sayornis nigricans (Swainson)
60. Nuttallornis borealis (Swainson)
61. Myiochanes richardsoni richardsoni (Swainson)
62. Empidonax difficilis difficilis Baird
63. Empidonax trailli trailli (Audubon)
64. Empidonax hammondi (Xantus)
65. Empidonax wrighti Baird
66. Empidonax griseus Brewster
67. Pyrocephalus rubinus mexicanus Sclater

68. Corvus corax sinuatus Wagler
69. Molothrus ater obscurus (Gmelin)
70. Xanthocephalus xanthocephalus (Bonaparte)
71. Agelaius phoeniceus sonoriensis Ridgway
72. Sturnella neglecta Audubon
73. Icterus cucullatus nelsoni Ridgway
74. Icterus bullocki (Swainson)
75. Euphagus cyanocephalus (Wagler)
76. Carpodacus mexicanus frontalis (Say)
77. Astragalinus psaltria hesperophilus Oberholser
78. Astragalinus lawrencei (Cassin)
79. Passer domesticus Linnaeus
80. Poœcetes gramineus confinis Baird
81. Passerculus sandwichensis nevadensis Grinnell
82. Passerculus sandwichensis alaudinus Bonaparte
83. Chondestes grammacus strigatus Swainson
84. Zonotrichia leucophrys leucophrys (Forster)
85. Zonotrichia leucophrys gambeli (Nuttall)
86. Spizella passerina arizonae Coues
87. Spizella breweri Cassin
88. Spizella atrogularis (Cabanis)
89. Junco oreganus thurberi Anthony
90. Amphispiza bilineata deserticola Ridgway
91. Amphispiza nevadensis nevadensis (Ridgway)
92. Melospiza melodia fallax (Baird)
93. Melospiza melodia saltonis Grinnell
94. Melospiza lincolni lincolni (Audubon)
95. Pipilo maculatus curtatus Grinnell
96. Pipilo aberti Baird
97. Oreospiza chlorura (Audubon)
98. Zamelodia melanocephala melanocephala (Swainson)
99. Guiraca caerulea lazula (Lesson)
100. Passerina amoena (Say)
101. Calamospiza melanocorys Stejneger
102. Piranga ludoviciana (Wilson)
103. Piranga rubra cooperi Ridgway
104. Petrochelidon lunifrons lunifrons (Say)
105. Hirundo erythrogastra Boddaert
106. Iridoprocne bicolor (Vieillot)
107. Tachycineta thalassina lepida Mearns
108. Stelgidopteryx serripennis (Audubon)
109. Bombycilla garrula (Linnaeus)
110. Phainopepla nitens (Swainson)
111. Lanius ludovicianus excubitorides Swainson
112. Vireosylva gilva swainsoni (Baird)
113. Lanivireo solitarius cassini (Xantus)
114. Vireo belli arizonae Ridgway
115. Vermivora luciae (Cooper)
116. Vermivora ruficapilla gutturalis (Ridgway)
117. Vermivora celata celata (Say)
118. Vermivora celata lutescens (Ridgway)
119. Dendroica aestiva sonorana Brewster

120. Dendroica aestiva brewsteri Grinnell
121. Dendroica aestiva rubiginosa (Pallas)
122. Dendroica auduboni auduboni (Townsend)
123. Dendroica nigrescens (Townsend)
124. Dendroica townsendi (Townsend)
125. Dendroica occidentalis (Townsend)
126. Oporornis tolmiei (Townsend)
127. Geothlypis trichas scirpicola Grinnell
128. Geothlypis trichas occidentalis Brewster
129. Icteria virens longicauda Lawrence
130. Wilsonia pusilla pileolata (Pallas)
131. Wilsonia pusilla chryseola Ridgway
132. Anthus rubescens (Tunstall)
133. Oreoscoptes montanus (Townsend)
134. Mimus polyglottos leucopterus (Vigors)
135. Toxostoma crissale Henry
136. Heleodytes brunneicapillus couesi (Sharpe)
137. Salpinctes obsoletus obsoletus (Say)
138. Catherpes mexicanus conspersus Ridgway
139. Thryomanes bewicki eremophilus Oberholser
140. Troglodytes aëdon parkmani Audubon
141. Telmatodytes palustris plesius (Oberholser)
142. Auriparus flaviceps flaviceps (Sundevall)
143. Regulus calendula cineraceus Grinnell
144. Polioptila caerulea obscura Ridgway
145. Polioptila plumbea (Baird)
146. Hylocichla ustulata ustulata (Nuttall)
147. Hylocichla guttata guttata (Pallas)
148. Hylocichla guttata nanus (Audubon)
149. Planesticus migratorius propinquus (Ridgway)
150. Sialia mexicana occidentalis Townsend

GENERAL ACCOUNTS OF THE BIRDS: RECORD OF SPECIMENS, DISTRIBUTION, VARIATION, BIOGRAPHICAL NOTES

Gavia immer (Brünnich)

Common Loon

There is in the Museum an adult-plumaged female specimen (no. 6403) of this species taken (probably by W. W. Holder) at "Mineral City in Colorado River" (=Ehrenberg) April 4, 1864.

Sterna forsteri Nuttall

Forster Tern

Adult male (no. 12616), secured May 4 at the mouth of the Gila River, Arizona, near Yuma; clearly a transient.

Phalacrocorax auritus albociliatus Ridgway

Farallon Cormorant

Cormorants were not noted until the vicinity of Laguna Dam was reached, and then only in small numbers. April 24 one was seen at an overflow pond on the California side above Potholes; and on the same date a small flock was observed in the distance flying up the river, close over the water. Four individuals were seen below Potholes, April 29.

A lone individual (no. 12617) was shot on the river, nearest the California shore, five miles northeast of Yuma, May 2. In this specimen the anterior lower parts forward to the chin are light drab with numerous black feathers scattered uniformly through; naked portion of gular pouch bright orange yellow; wing 322 mm., tail 164, tarsus 65, middle toe with claw 100, culmen 56, depth of bill at base 17.7. Although immature, this bird is unequivocally referable to *P. a. albociliatus*.

Pelecanus erythrorhynchos Gmelin

White Pelican

Although reported to be extremely numerous at times along the river, we saw only stragglers. One was seen March 22 on a mud bar in the river above Blythe; April 3 one was noted opposite Cibola flying down the river.

Mergus serrator Linnaeus

Red-breasted Merganser

February 18 two small flocks were seen a few miles below Needles; March 8 three individuals flew past our boat as we entered Chemehuevis Valley.

Anas platyrhynchos Linnaeus

Mallard

Encountered sparingly: a pair found at a lagoon in Chemehuevis Valley, March 10, and female adult (no. 12618) secured; two seen at a tule pond near Ehrenberg March 25; two seen in flight along the river within two miles above Yuma, May 5.

Nettion carolinense (Gmelin)

Green-winged Teal

Most numerous of the ducks wintering in the region. One of two females (nos. 12619, 12620) taken from a small flock February 26 near Mellen has scattered through the plumage of the lower surface from chin to crissum many feathers, the exposed terminal portions of which are brightly stained with a rusty color. The species was further noted in Chemehuevis Valley March 10, near Riverside Mountain March 17, and opposite Cibola April 4.

Querquedula cyanoptera (Vieillot)

Cinnamon Teal

An adult female (no. 12621) taken on the California side opposite Cibola April 3.

Spatula clypeata (Linnaeus)

Shoveler

Four observed on a mud bar opposite Cibola, April 4; one obtained: female adult, no. 12622.

Dafila acuta (Linnaeus)

Pintail

One obtained March 10 in Chemehuevis Valley: adult female, no. 12623.

Marila affinis (Eyton)

Lesser Scaup Duck

Two large flocks seen flying up the river above Ehrenberg March 24; one noted on a mud bar opposite Cibola April 4.

Erismatura jamaicensis (Gmelin)

Ruddy Duck

Four noted on a sand bar in the river four miles above the Laguna Dam, April 23; one secured: immature male, no. 12624.

Chen hyperboreus hyperboreus (Pallas)

Lesser Snow Goose

February 16 two small flocks were seen at Needles flying south; February 23 a flock was met with on a mud bar on the California side between Needles and Mellen.

Plegadis guarauna (Linnaeus)

White-faced Glossy Ibis

A dozen seen May 5 flying down the river along the Arizona shore four miles above Yuma.

Mycteria americana Linnaeus

Wood Ibis

A flock of twelve individuals seen April 21 flying up the river, at a point about four miles above the Laguna Dam. Said by residents of the region to occur abundantly along the river at the present time, just as recorded in the '60's by Coues (1866, p. 96) and Cooper (1869, p. 481).

Ardea herodias treganzai Court

Pallid Blue Heron

Abundant resident along the whole course of the river as far as explored. Nesting colonies were observed in trees at many points through the large valleys; and one group of nests was noted on a pinnacle of rock in the narrow cañon just below The Needles. Ordinarily nests were placed in the tips of the largest cottonwoods in the neighborhood. Special predilection was evinced for dead trees standing close to the river. This would seem to be because of the clear fly-way afforded to and from the nests; and because of the more extensive outlook possible. But there were in this region drawbacks to these advantages.

In a number of places the river was rapidly undercutting the outside curve of its bank, on which stood occupied nest trees. Though

we did not witness such a catastrophe in the few minutes consumed in floating by such places, many trees were on the verge of toppling; the annual mortality from this local condition alone must be large. Evidently the herons have failed to grasp the situation, and cling to old habits, even though these entail considerable annual loss. The area in which this destruction occurs is so small compared with the entire range of the pallid blue heron, and the proportion of the local birds which suffer disaster to their nests is also so small, that the contingency in question has not effected any change in the habits of the birds.

Ten miles below Ehrenberg, on the California bank of the river, was a colony which was visited on March 30. There were approximately thirty nests, one to three per tree, which were unquestionably occupied, besides others in various stages of construction or dilapidation. The place had evidently been inhabited for at least one year previously. One nest, situated forty feet above the ground in a cottonwood, contained three fresh eggs. The time of laying in this region is thus indicated.

Inspection of the nests of a colony on the Arizona side four miles above Laguna, April 25, showed young perhaps one-third grown. They could be seen from the ground clambering about the nest-platforms. Another colony, on the Arizona shore five miles northeast of Yuma, passed May 2, showed young appearing conspicuously above the nest rims, and their hoarse calls were to be heard to a considerable distance.

Along the whole course of the river, save in the rock-walled box cañons, blue herons were almost continually in sight. Their chief foraging grounds were the mud bars traversed by shallow diversions of the river. The habit of the river of having frequent periods of falling water, even when, as in the spring, the aggregate tendency is to rise, results in the stranding of many fishes in the shallow overflows as the water seeps away or evaporates. This frequently recurring supply of fish appears to be the chief source of food of all the species of herons occurring in the region. The stomach of one blue heron contained a semi-liquid mass of fish, identifiable from the large-sized scales as carp; another contained a large catfish. One stomach was empty save for a single grasshopper leg; this gives a clue as to an emergency diet, when the river is rising rapidly. It may be remarked that the opacity of the moving water of the main stream is so complete as effectually to prevent fishing here by piscivorous birds in the usual manner.

Twelve specimens of this heron were secured, two (nos. 12625, 12626) from the California side near Riverside Mountain, one (no. 12627) from the Arizona side at Ehrenberg, and nine (nos. 12628–12636) from the California side about ten miles below Ehrenberg. In the accompanying table of measurements of the fourteen apparently mature specimens a wide variation will be noted. While the largest individuals of the series are males, some females are larger than some males. I find nothing to indicate that size increases with age, though this might fairly be expected. The average of the series accords closely with the measurements given by Court (1908, p. 292) for *Ardea herodias treganzai* (except as resulting from obviously different methods of measuring, as with middle toe).

The status of the great blue herons residing in California west of the Sierran divide has been recently settled by Oberholser (1912, p. 550). As compared with these all of the Colorado River skins are markedly pale throughout, with reduction in extent of dark areas. Bills straw yellow, darkening on culmen, not "black," as stated by Court (1908, p. 291).

The weights of two freshly killed males were 5½ and 5¾ pounds, of two females 5 pounds each.

MEASUREMENTS IN MILLIMETERS OF *ARDEA HERODIAS TREGANZAI* FROM THE LOWER COLORADO RIVER AND VICINITY

Museum No.	Sex	Wing	Tail	Tarsus	Middle Toe and Claw	Culmen	Depth of Bill
12625	♂	493	186	193	132	157	28.0
12626	♂	462	162	165	123	142	26.0
12627[1]	♀	441	164	172	120	142	25.0
12628	♂	488	192	178	128	143	28.0
12629	♀	442	168	167	121	143	26.0
12630	♀	468	172	166	114	140	26.5
12631	♂	466	169	180	129	149	26.8
12632	♀	465	175	173	116	136	26.0
12633	♂	478	176	180	126	150	28.4
12634	♂	492	184	190	129	154	29.0
12635	♀	453	167	162	121	141	25.6
12636	♀	445	172	158	118	144	25.8
1070[2]	♀	450	170	169	114	150	25.0
8041[3]	♂	445	174	175	124	141	28.0
Averages		463	174	173	122.5	145	26.7

[1] The plumage of this specimen is not in full breeding condition, and the bird may not have been full grown, in respect to flight feathers especially.

[2] Pelican Island, Salton Sea, Calif., April 20, 1908.

[3] Silsbee, Imperial Co., Calif., April 4, 1909.

Herodias egretta (Gmelin)

American Egret

Met with only in one place, the recently silted-in area above the Laguna Dam. About five miles north of Laguna, on the Arizona side and about one half mile back from the river, were extensive shallow lagoons sprinkled with numerous water-killed mesquites. Here herons found seclusion and feeding grounds. April 22 to 25 we frequently saw individuals of the egret, to the number of three at one time; but because of the deep mud and water we were unable to stalk them. Usually they were seen in flight from one portion of the bog to another; one, however, was seen perched on a dead mesquite, preening.

We were told that in summer, after the overflow begins subsiding, there is a large influx of white herons and ibises from the south. This would appear to be accounted for by the abundant food-supply in the way of fish left in the drying ponds as the river lowers. This constitutes a local condition, therefore, serving to modify the seasonal movements of these birds.

There is in the Museum a skin (no. 4492) taken by J. G. Cooper at Fort Mohave, January 9, 1861.

Butorides virescens anthonyi (Mearns)

Anthony Green Heron

First seen April 24, five miles above Laguna. Thenceforth common all along the river below, and up to the time of our departure, May 15. As far as observed up to the latter date the species was still in migration. We found no evidences of breeding. Seven specimens were taken, nos. 12645–12651, from Potholes, near Yuma, and near Pilot Knob, all on the California side.

Nycticorax nycticorax naevius (Boddaert)

Black-crowned Night Heron

Eight specimens secured (nos. 12637–12644). Three, taken March 25 and April 20, are immatures in the streaked plumage; the rest are in more or less perfect adult plumage.

Since one individual was seen February 18, near The Needles, it is probable that the species winters in the region, though sparingly.

March 16 one was seen below Parker. March 25 about fifty night herons were found at a tule pond below Ehrenberg. Of these, approximately forty were in the streaked immature plumage, only the relatively small remaining proportion being fully adult-plumaged birds. Farther down the river the species was common, being often startled from diurnal roosting places in the willows bordering the river. Individuals were not seen stalking fish during the day, as did the blue herons; but their activity about sloughs and mud bars began with the dusk of evening, and, as indicated by their voices, continued all night.

Among the adult specimens are some, no. 12643 in particular, which are extremely pale, almost pure white beneath, with the outer surfaces of the closed wings very light lavender. These are noticeably paler than the few specimens at hand from elsewhere. We found no indication, however, that the species occurs in the region otherwise than as a migrant and winter sojourner.

There is in the Museum an immature specimen (no. 4496) taken by J. G. Cooper at Fort Mohave, March 12, 1861.

Grus canadensis (Linnaeus)

Little Brown Crane

Cranes were seen daily, March 1 to 8, in northward flight past The Needles. A large flock spent the night of March 9 on a mud bar in the river at the lower end of Chemehuevis Valley. This roosting ground was about midway between the high wooded banks of the river, and about two hundred yards from either bank. The cranes had thus selected a place which could not be approached except in the open, and were evidently on their guard all night. They were just opposite our camp; every now and then something would disturb them and a chorus of sonorous calls and wing-flappings would ensue for a minute or more.

It is believed that these migrating cranes are more likely to have been *Grus canadensis* than *Grus mexicana*. I believe the latter to be far less common, especially of late years, than generally supposed.

Recurvirostra americana Gmelin

Avocet

There is in the Museum a skin, no. 7069, taken probably by W. W. Holder, at "Mineral City" (=Ehrenberg), February 12, 1864.

Fulica americana Gmelin

Coot

Noted but sparingly: Six seen on a tule pond below Ehrenberg, March 25. Several noted along margins of the main river near Pilot Knob, May 9 to 15; here they found concealment among the overhanging masses of cane trailing in the water. Two specimens taken, nos. 12652, 12653.

Pisobia minutilla (Vieillot)

Least Sandpiper

A band of eight seen February 24, and another of a dozen February 27, on the Arizona shore a mile above Mellen; they were at the margin of an overflow pond. About a dozen were found similarly on the California side eight miles east of Picacho. Two specimens, nos. 12654, 12655, were secured there April 20.

Actitis macularius (Linnaeus)

Spotted Sandpiper

Frequently observed all along the river, on both sides, practically throughout the period of our work. First seen, two individuals, February 18, a little below Needles; last seen, six individuals, May 9, near Pilot Knob. In spite of the lateness of the last date, there was no evidence leading to the belief that the species breeds in the region. Two specimens, nos. 12656, 12657, taken March 20 near Riverside Mountain and March 31 near Palo Verde, are in winter plumage; a third, no. 12658, taken May 1, four miles below Potholes, is in full summer plumage.

Oxyechus vociferus vociferus (Linnaeus)

Killdeer

Noted sparingly, not more than a pair at one time, but at a number of points and almost throughout the season: Above Mellen, February 23; above Bill Williams River, March 14; near Riverside Mountain, March 17; opposite Cibola, April 1; eight miles east of Picacho, April 19; four miles above Potholes, April 23; five miles above Lag-

una, April 26; Potholes, April 28; five miles northeast of Yuma, May 2. In the last four cases the behavior of the birds at the time aroused the supposition that they were nesting in the respective vicinities. But recalling the tattler-like actions of the killdeer on occasions at other seasons, I do not now consider the evidence at all conclusive. Two killdeers were preserved, nos. 12659, 12660.

Lophortyx gambeli Gambel

Desert Quail

Desert quail were numerous on both sides of the river almost continuously down to the Picacho region. Below this they were notably scarce, in fact apparently wanting at several of our stations. A few were seen at Pilot Knob. Along the whole course of the river the quail are close associates of the mesquite and quail-brush (*Atriplex lentiformis*). They also forage widely on the adjacent desert, especially up the washes lined with catclaw and ironwood. But in all cases the river is their base, as they apparently need to drink both morning and evening. Stomachs of birds shot contained masses of mistletoe berries, and, at the time the mesquites were just coming into leaf, quantities of the tender green foliage of this plant. Nineteen specimens of the desert quail were preserved, nos. 12661–12679. The combined weight of three males shot February 21, five miles south of Needles, was sixteen ounces; of three females fifteen ounces.

There are in the Museum four skins (nos. 4446–4449) taken by J. G. Cooper at Fort Mohave in 1861.

Zenaidura macroura marginella (Woodhouse)

Western Mourning Dove

First seen February 25, on the Arizona side above Mellen; a flock of about seventy-five were scattered out feeding on the ground among the creosote and bushes of *Atriplex polycarpa*. Doves were not again noted until March 18, near Riverside Mountain; but thenceforth they were seen at nearly every station, and sometimes in considerable numbers. As elsewhere in desert regions, doves visited the water at dusk, arriving from a distance over the mesas. Up to May 13 in the vicinity of Pilot Knob, the species was still in evidence; it is probably resident in the region.

Four specimens were secured, nos. 12680–12683.

Melopelia asiatica trudeaui (Audubon)

White-winged Dove

First noted on the California side at Potholes, where, on April 29, one was heard in a willow thicket and finally secured (no. 12684, ♂). At our station on the California side, five miles northeast of Yuma, the species was common. The hoarse note, so characteristic of this dove, was to be heard at almost any hour of the day from the dense woods close to the river. As many as three were heard at one time from as many directions. Careful stalking usually resulted in discovering the performer among the uppermost branches, usually dead ones, of the largest cottonwood in the vicinity, surrounded by dense living willow and cottonwood timber. The crop of one shot here May 5 (no. 12685, ♂) contained thirty-three watermelon seeds and one muskmelon seed. In the bottom lands on both sides of the river in the vicinity of Pilot Knob white-winged doves were common. One was taken on the California side May 12 (no. 12686, ♀). This species is here a strict adherent to the willow association.

Cathartes aura septentrionalis Wied

Turkey Vulture

First seen, near Mellen, February 25; thenceforth of daily note everywhere we went, both in the river bottom and far out over the desert. Last observed May 13 at Pilot Knob. We were continually bothered in our mammal trapping by these birds. Wherever meat bait was used and the steel traps left out during the day unsprung, no matter how far back under thick bushes these were placed, and so concealing the setting from view, the turkey buzzards were almost certain to get caught. Fully two dozen were thus captured, and, being seldom severely injured, were usually released. One, no. 12687, was saved as a skin, and two more, nos. 12712, 12713, as skeletons. Another specimen in the Museum, a skin (no. 5937), was taken probably by W. W. Holder at "Mineral City" (=Ehrenberg), March 10, 1864.

Circus hudsonius (Linnaeus)

Marsh Hawk

February 23 an adult was seen on the Arizona side and an immature on the California side, both between Needles and Mellen. April 2 a marsh hawk flew north along the California side opposite Cibola.

Accipiter velox (Wilson)

Sharp-shinned Hawk

Apparently a common winter visitant to the Colorado River bottom, adhering closely to the willow belt. Seen in the vicinity of Needles, February 16, 20, and 21; at Mellen, February 24; in Chemehuevis Valley March 9; ten miles south of Cibola April 8; twenty miles above Picacho, April 14 and 16; and five miles above Laguna April 24. The latter date probably indicates about the time of departure. Two specimens were obtained, nos. 12690, 12691.

There is also in the Museum a skin (no. 4380) taken by J. G. Cooper at Fort Mohave, January 4, 1861.

Accipiter cooperi (Bonaparte)

Cooper Hawk

Seen in February and March; to our surprise this proved to be also a breeding species of the region. It was confined almost altogether to the timbered bottom lands. Definite points and dates of observation were: Mellen, February 26; above Bill Williams River, March 13; eight miles east of Picacho, April 19; four miles north of Potholes, April 23; five miles north of Laguna, April 24; Potholes, April 29; and five miles northeast of Yuma, May 3.

On April 19 a female bird (no. 12693), with two eggs, was secured on the California side eight miles east of Picacho. The nesting site was in a tract of tall willows, free from undergrowth, and closely paralleled by the river on one hand and an open mud flat on the other. The nest tree was relatively slender and leaning, its top about on a level with the crowns of the rest of the grove in the vicinity, and stood fifty yards from the river's edge. The nest was about twenty-five feet above the ground, lodged among the branches of the willow near its top, and was a small, loosely constructed platform composed wholly of dry willow twigs. The two eggs it contained were fresh. Although the female bird had already begun to sit closely, as we were able to determine because the nesting site happened to be only a few yards from our camp at this place, the set was incomplete. Dissection of the bird showed that two more eggs would have been laid.

One of the eggs of the set (Mus. no. 765) has sparse speckling of liver brown about the large end; both have equivocal nest stains; otherwise they are very pale nile blue. They are *small,* measuring

in millimeters 45.0 by 37.2 and 45.6 by 36.5. The average for the species, as given by Bendire (1892, p. 195), is 49.0 by 38.5. This is another instance of diminution in the size of the eggs in the southern part of the range of a species. It is not paralleled in this case by decrease in size of the birds themselves. The three specimens of Cooper hawk obtained from the Colorado Valley (nos. 12692–12694) are in no respect smaller than individuals taken in the breeding season in the Transition zone, where large eggs are laid. The explanation possibly lies in the demands of the developing embryo for a larger supply of heat-producing food in the colder zone. Even though this species incubates closely, the temperature of the egg after deposition is doubtless affected to some extent by that of the outside air.

There is in the Museum an immature female specimen of this hawk (no. 4378) taken by J. G. Cooper at Fort Mohave, April 27, 1861.

Buteo borealis calurus Cassin

Western Red-tailed Hawk

This hawk proved to be regularly distributed along the valley of the Colorado, both in its timbered portions and where it cut through mountains. Yet the species was not nearly as numerously represented anywhere along the river as it is ordinarily on the Pacific slope of California. Exact places of observation were: five miles below Needles; both sides of the river at The Needles; above Bill Williams River; Ehrenberg; ten miles below Cibola; twenty miles north of Picacho; four miles south of Potholes. All adults seen by us closely enough for determination in this regard, were in the light phase of plumage coloration. There is, however, in the Museum an adult female specimen (no. 4372) taken by J. G. Cooper at Fort Mohave, April 3, 1861, which is distinctly in the dark phase. There is also a specimen (no. 4373), same place and collector, taken March 7, 1861, which is in immature plumage, and at least as heavily marked as skins in like stage from the California coast region.

Falco mexicanus Schlegel

Prairie Falcon

Two pairs were seen along the steep rock wall of the cañon immediately below the mouth of Bill Williams River. An evident aerie was noted some 200 feet above the water in a hole near the top of the face of a cliff.

Falco columbarius richardsoni Ridgway

Richardson Pigeon Hawk

There is in the Museum a female specimen (no. 4388) taken by J. G. Cooper at Fort Mohave, January 21, 1861.

Falco sparverius phalaena (Lesson)

Desert Sparrow Hawk

First noted March 31, two flying north over the river ten miles below Ehrenberg. Next observed April 15, twenty miles above Picacho. Otherwise found only in the saguaro belt on both sides of the river within five miles above the Laguna Dam. Here the species found favorable nesting sites in the deserted burrows in the giant cactuses, made by gilded flickers and Gila woodpeckers. A set of five eggs, in which incubation was far advanced, was found eleven feet above the ground in an eighteen-foot saguaro on the California side, April 23. An elf owl was taken at the same time from a hole in the opposite side of the trunk. The excavation in which the hawk's eggs were laid, opened to the south.

The only specimen secured by the expedition was an adult female (no. 12689) shot among the saguaros on the Arizona side of the river five miles above Laguna, April 22. This bird is markedly different from any one of a series of twenty-seven adult females from California, Nevada, Washington, Alaska, and the western United States generally, which series I would call *Falco sparverius sparverius*. Yet it does not accord, particularly in size, with Mearns's characterization (1892, p. 263) of *Falco sparverius deserticola*. As compared with average examples of *sparverius*, as represented in the series referred to, the specimen in question is decidedly smaller, except bill: wing 178, tail 113, tarsus 34, middle toe and claw 31, bill from nostril 11, culmen from cere 12, depth of bill 9.4; the browns of the upper and under surfaces are more reddish, the brown area on top of head very broad and pure cinnamon-rufous without trace of plumbeous shaft-streaks, the plumbeous of head reduced to narrow frontal and superciliary tracts continuous with one another, shaft-streaks of pectoral region narrow, barrings on dorsum very narrow, the widest only 3 mm. instead of 7.

It will thus be seen that in all essential respects this specimen meets with the description of *Falco sparverius peninsularis* Mearns (1892, p. 267), of the southern extremity of Baja California. Mearns expressly states in this connection that all of the sparrow hawks examined by him from the southern borders of California and Arizona are of the large "deserticolus" type. I might dispose of the peculiar Colorado River example by referring it to *peninsularis* without further ado. But I do not consider this a reasonable course, unless later acquisition of numerous specimens should show that the sparrow-hawk of the saguaro belt here and that of Lower California is normally like the one in hand and hence different from that of the surrounding regions. This I now doubt, preferring rather to consider the bird in question as an extreme of individual variation in the direction of *peninsularis*, but to be identified with the obvious geographic stock-form, *F. sparverius sparverius* (or *F. s. phalaena* Lesson [= *F. s. deserticola* Mearns], if a southwestern desert form be considered different from *sparverius* proper of the north and east).

There is in the Museum a male specimen (no. 4390) taken by J. G. Cooper at Fort Mohave, December 24, 1860. This may or may not have been a winter visitant. But it, too, is small as though possibly representative of a resident race. It measures: wing 175, tail 111, tarsus 31.0, middle toe and claw 31.3, bill from nostril 10.5, culmen from cere 11.1, depth of bill 9.2. In coloration this specimen, also, has the black markings of the mantle reduced to mere indications.

Pandion haliaëtus carolinensis (Gmelin)

Osprey

One specimen (female, no 12688) taken April 17 on the California side of the river seven miles east of Picacho. Another seen flying over the river a mile or so above Yuma, May 5. Evidently a migrant through the region.

Aluco pratincola (Bonaparte)

Barn Owl

Feathers of a barn owl were seen on the California side at Riverside Mountain. Its presence was nowhere else detected until we reached our last station near Pilot Knob. Here in a low bluff on

the California side, where the river swings northwest against the mesa, a nesting site was located as we floated past on May 5. The place was revisited on May 10, and the hole in the partly cemented gravel face, fifteen feet above the water, was ascertained to contain four downy young. Two of these were preserved (nos. 12695, 13979).

Otus asio gilmani Swarth

Saguaro Screech Owl

The widespread presence of screech owls was brought to our attention by their notes heard almost nightly and at nearly every one of our camps from Needles all the way down the river, clear to Pilot Knob. The birds appeared to occur both in the willow and cottonwood timber close along the river, and out on the desert. They were heard from the precipitous sides of The Needles, the numerous crannies in the rock walls of which may have afforded the birds daytime concealment. At Mellen, Arizona, February 27, a female screech owl (no. 12696) was captured in a trap set near the house of a wood-rat (*Neotoma albigula venusta*) under a mesquite and baited with portions of a wood-rat found partly eaten in the same trap the night before.

On the California side, twenty miles north of Picacho, April 16, one (no. 12697) was shot at night in a willow when giving the characteristic deep-toned succession of mellow notes; it proved to be a male.

April 23, on the California side four miles above Potholes, two were taken from holes in giant cactuses. A male (no. 12698) was taken from an otherwise empty cavity ten feet above the ground. A female (no. 12699) occupied a cavity nine feet above the ground. This hole was rather small, evidently originally excavated by the Gila woodpecker; but it held besides the old owl, three newly-hatched young (preserved as alcoholics, nos. 13976–13978), and the fresh, headless bodies of four mammals: two *Perognathus penicillatus penicillatus*, one *Dipodomys merriami merriami*, and one *Peromyscus maniculatus sonoriensis*.

The four adults specified above, together with a fifth in the Museum (no. 4395) taken by J. G. Cooper at Fort Mohave, February 24, 1861, are all typical of the subspecies *gilmani* as described by Swarth (1910, p. 1).

Bubo virginianus pallescens Stone

Western Horned Owl

The hooting of horned owls was heard almost nightly at every one of our camps, from Needles to Pilot Knob. The birds themselves were occasionally seen flying overhead at dusk, and twice, on the California side at Riverside Mountain and opposite Cibola, were flushed in the daytime from dense ironwood trees in desert washes back from the river. Three specimens were shot (nos. 12702–12704). These are markedly pale, as compared with *Bubo virginianus pacificus* of the coastal slope of southern California, and in their characters closely approximate specimens from central Arizona which in turn have been referred to *B. v. pallescens* (see Oberholser, 1904, p. 182).

Micropallas whitneyi (Cooper)

Elf Owl

The elf owl was detected only in the belt of saguaros which extends across the Colorado Valley within six miles above the Laguna Dam. The numerous excavations in the trunks of these great cactuses evidently furnish desirable diurnal retreats for owls of size small enough to render them usable. By chopping into many of the perforated saguaros we succeeded in capturing two of this species, nos. 12700 and 12701. The latter was taken on the Arizona side, April 22, from a hole twelve feet above the ground. The cactus in which it was located was a single column thirty-one feet high and twenty-six inches in diameter. In the same trunk, four and one-half feet higher up, was an occupied nest of the gilded flicker. The other bird was taken April 23 on the California side four miles above Potholes. The cavity occupied in this instance was twelve feet above the ground in a three-branched saguaro eighteen feet tall and twenty-six inches in diameter.

In the same trunk one foot lower, but opening on the opposite side, was a cavity occupied by a sparrow hawk and its five eggs. Both owls were females, and each showed signs of immediate breeding. In one case dissection disclosed five large ova of graded size, the largest being an apparently full-sized yolk.

The locality where our California specimen was secured is some two miles west of the river and not far from the old Senator Mine. It is in a valley leading down from the hills and locally known as

the Senator Mine Basin. It was doubtless in the limited tract of saguaros here that Brown (1904, p. 46) found the species nesting on May 17, 1903, and secured two sets of four eggs each. We noted the old scars on the largest cactuses where holes had been chopped into, years before our visit. Brown's was the first authentic record of the elf owl for California. But Cooper found the species on the Arizona side of the river, near Fort Mohave, whence on April 26, 1861, he secured the type, now in the National Museum, though at one time the property of the State of California (see Cooper, 1870, p. 443).

Geococcyx californianus (Lesson)

Roadrunner

Safely to be considered a common resident of the whole region traversed. Noted at every collecting station on either side of the river, from Needles to Pilot Knob. Noted with equal frequency on the upland mesas and hills, and on the first bottom even to the water's edge. The peculiar notes were on several occasions heard from opposite shores as we floated along, as though birds were answering one another from across the water.

Two examples came into our possession through being caught in meat-baited steel traps set for carnivorous mammals. The stomach of a roadrunner obtained at Needles contained remains of beetles and one half-grown lizard (*Cnemidophorus*).

The five specimens secured by us (nos. 12705–12709), and another (no. 4369) taken by J. G. Cooper at Fort Mohave, March 26, 1861, give a uniform impression at first glance of paleness, as compared with roadrunners from the Pacific slopes of southern and central California. This paleness consists in an apparent greater average extent of white markings and particularly in the whitening of the buffy lower surface and a paling of the buffy margins of the dorsal feathers. The Pacific slope series, however, includes specimens taken at all seasons of the year, and it becomes apparent at once that the deepest buffy specimens in it are those in the freshest (that is, fall) plumage. The variation in the Pacific series in this respect is great, and leads to the conclusion that the paleness of the buffy tints of the Colorado desert series, which are February to May examples, is not altogether intrinsic, but

due in part at least to an extreme amount of fading. This does not, however, account for the average greater extent of white areas on the individual feathers of the desert birds. But this feature is too variable in both series to be satisfactorily defined.

It is of course a remarkable exception if the roadrunner, a terrestrial, permanently resident bird of all the areas it inhabits, should not show some geographic color peculiarities. Indeed it is all the more strange that it does not show conspicuous differences in color tone in the arid and subhumid areas it occupies, when we observe the markedly different color tones exhibited by the thrashers, towhees, spermophiles, and jack rabbits of the same areas, these being also terrestrial animals.

The roadrunner's failure to conform to the rule offers a problem for those who would explain animal coloration wholly on the grounds of physiological response to meteorological conditions, irrespective of adaptive value.

Ceryle alcyon (Linnaeus)

Belted Kingfisher

Our observations would indicate that this species occurred only as a migrant through the region. The first individual was noted April 6 on the California side below Cibola; another was seen on the seventh on the Arizona side ten miles below Cibola. In both these cases, and also subsequently, the birds were perched on snags intently watching the muddy current. But the futility of their scrutiny was apparent in that at no time was a kingfisher seen to plunge into the water in the characteristic fashion of the species when capturing a fish; the opacity of the mud-laden water was most certainly unfavorable to this mode of securing fish. Kingfishers, but one at a time, were seen April 19, eight miles east of Picacho; May 3, five miles northeast of Yuma; and May 5, near Pilot Knob.

There was not the least doubt in any of these instances that the bird seen was the large belted kingfisher and not the little Texas green kingfisher. Coues's oftquoted statement (1866, p. 59) that he observed the latter species "at several points on the Colorado River between Forts Mohave and Yuma" in the autumn of 1865 remains unconfirmed by any later observation.

Dryobates scalaris cactophilus Oberholser

Cactus Woodpecker

Common resident of the willow and mesquite associations along the whole of the explored portion of the river. In but one place was the species seen outside of the riparian strip. The exceptional case was on the Arizona side above Mellen, where several individuals were seen over a mile up the Sacramento Wash, affecting dead or sickly palo verde trees. At Needles, February 17 and the few days following, this woodpecker was common in certain portions of the river bottom, where, however, its habit of working near the ground in young growth, together with its winter quietude, rendered it very inconspicuous. Within a month later, those seen along down the river had become noisy, and the presence of the species was readily detected, even as we floated along from one station to another.

On April 11, on the California shore twenty miles north of Picacho, a nest was found situated twelve feet above the ground in a willow stub, the upper part of which was dead and centrally decayed. The excavation freshly made in this by the birds opened on the under side of this slanting terminal section. There were three eggs on the point of hatching, and one newly hatched young, showing the date of egg-laying to have been toward the last of March.

On the California side below Potholes parts of the willow area had been burned over as a preliminary to clearing the land. The woodpeckers here were much discolored ventrally by contact with charred tree trunks, yet they appeared to be thriving quite as well as if arrayed purely in their normal colors.

Fourteen specimens of the Texas woodpecker were secured, nos. 12714–12727. Besides these there are in the Museum six skins (nos. 4315–4320) taken by J. G. Cooper at Fort Mohave, December 31, 1860, and in January and February, 1861; and another taken at "Mineral City" (=Ehrenberg) March 10, 1864, collector not recorded.

For the use of the name *cactophilus* in replacing the older name *bairdi*, formerly in general use for this woodpecker, see Oberholser (1911, p. 152).

Sphyrapicus varius nuchalis Baird

Red-naped Sapsucker

Evidently a winter visitant to the Colorado Valley, where we found it for a time common among the willow thickets. Localities of capture

were: the immediate vicinity of Needles, opposite The Needles, and Lower Chemehuevis Valley. At the first two places several were seen that were not also taken; at the latter point but the one, taken March 11, was noted. This probably indicates the approximate date of departure from the region, as we saw none thereafter. Willows were the trees attacked by this woodpecker; but in one case a single large mesquite, and only this one out of many in the vicinity, had been selected for bleeding, and its main trunk and larger branches were plentifully bored. I visited this tree many times during the space of three days, March 2 to 4, opposite The Needles, and invariably found a sapsucker working about the borings. I shot two of the birds at this mesquite, and there was still one there the last time I visited the tree, although I had never seen but one at a time there.

The five specimens secured (nos. 12728–12732), all from the California side, are characteristic of the subspecies.

There is a skin in the Museum, no. 4312, taken by J. G. Cooper at Fort Mohave, February 20, 1861.

Centurus uropygialis Baird

Gila Woodpecker

A common and characterstic resident the whole length of the region, from Needles to the vicinity of Yuma. Found at every station on both sides of the river. While regularly present in the willows and cottonwoods of the river bottom, the species occurred also up the desert washes a mile or more from the edge of the riparian strip. This was the case on the Arizona side above Mellen, and on the California side opposite Cibola, and on the Arizona side ten miles below Cibola. At the latter two points Gila woodpeckers were feeding on mistletoe berries in the ironwoods. At the last named place, an excavation fifty-four inches above the ground in a dead broken-off branch of a palo verde contained a single fresh egg, April 7. The nest cavity appeared to be an old one, perhaps dug out the year previous. On the California side twenty miles above Pieacho a nest was found twenty-five feet above the ground in a broken-topped living willow, the core of which was rotten. There were three small young, April 15.

The Gila woodpecker was one of the birds conspicuously associated with the giant cactus. Where a scattering growth of this plant reached nearly to the river on the Arizona side east of Ehrenberg, several of these birds were encountered far out on the mesa and many of the

larger cactuses contained from one to four holes each. At the date they were examined, March 27, egg-laying had not yet commenced.

Where the better defined belt of saguaros meets the Colorado above the Laguna Dam, with well represented tracts on both sides of the river, the Gila woodpecker abounded. The availability of satisfactory sites would therefore seem to be the prime factor in governing the local distribution of this species. For the cactus itself certainly would not seem to afford food, except during the fruiting season, or other attractions.

In this vicinity nests were found in saguaros as follows: On the Arizona side, five miles above Laguna, April 24, a set of three fresh eggs, twelve feet above the ground; on the California side, four miles above Potholes, April 23, nest (not investigated) twenty-four feet above the ground; another nest, same place and date, fourteen feet above the ground, with four small young.

In the same vicinity Gila woodpeckers were nesting also in dead cottonwoods in the river bottom. The birds appeared to find favorable foraging grounds both in the riparian tracts and out on the desert.

A series of twenty-three adult specimens was taken, nos. 12733–12755.

There are five other skins in the Museum, nos. 4330–4334, taken at Fort Mohave by J. G. Cooper, December 24 and 25, 1860, and February 4 and March 12, 1861. It is to be remarked that not an iota of difference, save as is accountable for by extraneous causes, is observable between the Cooper birds obtained fifty years ago and the freshly obtained material. Considering the rather intricate color pattern and the opportunity thus afforded for the detection of determinate or any other sort of variation, this is indicative of constancy of characters under natural conditions through a long series of generations.

Colaptes cafer collaris Vigors

Red-shafted Flicker

Evidently a common winter visitant. Noted daily the third week of February in the willow timber of the river bottom below Needles, and early in March in the narrower willow association on both sides of the river opposite The Needles; likewise in Chemehuevis Valley. The last individual of the species observed, was shot in the willows on

the California side near Riverside Mountain, March 16. Five specimens in all were secured, as listed in the table presented under the discussion of *Colaptes chrysoides mearnsi*.

There is in the Museum another skin (no. 4325) taken by J. G. Cooper at Fort Mohave March 12, 1861.

Colaptes chrysoides mearnsi Ridgway

Mearns Gilded Flicker

Detected by our party only in a restricted area within six miles north of Laguna Dam. This area of occurrence coincided with the westward extension across the Colorado Valley at this point of a belt of the giant cactus, or saguaro. Here this woodpecker was fairly common, probably as a permanent resident. While closely restricted on the desert to the saguaro belt, at least two pairs were nesting in dead cottonwood stumps in the drowned-out area of the river bottom. A nesting hole located here was eighteen feet above the ground, in a large stub. It is probable that the species occurs, or has occurred in the past, along the bottom timber up and down the river, though not seen by us. The year 1910 may have been one of a series of unfavorable years when the range of the species was retracting through dying-off of the frontier individuals. We saw near Pilot Knob and at several places above Picacho excavations in willows and cottonwoods, which were too large for the Gila woodpecker, and in all probability were made some years before by gilded flickers. Moreover, the Museum contains two of Cooper's specimens, taken at Fort Mohave, considerably above Needles, February 23 and April 2, 1861 (nos. 4328, 4329). Cooper (1870, p. 411) found "two pairs" there, in cottonwoods.

Nests of the gilded flicker were found by us, in the saguaro belt above referred to, as follows: On the Arizona side, April 22, excavation sixteen and one-half feet above the ground in cactus thirty-one feet high, contained two fresh eggs; April 24, excavation twenty feet above the ground, not investigated. On the California side, April 23, excavation ten and one-third feet above the ground, in cactus twenty-eight feet high, contained one infertile egg and two small young. The two parent birds taken with the latter had their gullets distended with a mass of small black ants and ant larvae. It was in this same place that Brown (1904, p. 46) found a nest of this bird in 1903.

Of the five specimens secured by us only one has the shafts and under surfaces of the wings and tail yellow as in the two Cooper specimens from Fort Mohave. Reference to literature shows that this yellowness is generally supposed to be a constant character of *chrysoides*. In fact I find but four recorded exceptions: Brewster (1883, p. 25) mentions a specimen taken at Tucson, Arizona, as "having the yellow of the wings and tail replaced by orange, while the shafts of many of the feathers show an even stronger reddish cast, those of the rectrices at their bases being especially deep in color." Brewster remarks further that "this departure from the normal coloring undeniably narrows the gap which separates *chrysoides* from *mexicanus* [=*collaris*], but it may be merely a chance reversion, or, what is perhaps still more likely, the specimen in question may be a hybrid." Cones (1903, p. 602) observes that "gradation between this form [*chrysoides*] and *C. mexicanus* [=*collaris*] has not yet been observed."

Swarth (1905, p. 27) discusses at length an aberrant specimen from the Papago Indian Reservation, Arizona, evidently in the same category as Brewster's. Swarth considers this a hybrid between *chrysoides* and *collaris*, although he goes on to say that he found these two species in that region "breeding almost side by side, practically without mixing," and this seems strange "when we consider the extensive hybridization that takes place in the northwest, where *collaris* and *luteus* come together."

Breninger (1898, p. 13) reports two supposed hybrids between the "gilded" and "red-shafted" flickers. But these are probably of the same nature as Brewster's and Swarth's.

The abnormal appearance of four out of five of the flickers collected by us on the lower Colorado, and the circumstance that this abnormality consists in a redness approximating the color of corresponding areas in *collaris*, led us to conclude at the time that we had there found *chrysoides* and *collaris* hybridizing. The chief characters of the specimens in question are shown in an accompanying table; also the corresponding characters of those examples of *collaris* taken by us in the Colorado Valley. The latter, it should be emphasized, are believed to have been winter visitants to the region, and not representative of the breeding species.

No. 12761, male of typical yellow *chrysoides*, and no. 12762, female with under surfaces of wings and tail coral red, were a mated pair, the parents of the young found in a saguaro on the California side. These young, preserved as alcoholics, are in too early a stage for the

colors in the rudiments of their feathers to be ascertained. Nos. 12763 and 12764, both with reddish coloration, were a mated pair taken in the overflow bottom on the Arizona side. No. 12765, of reddish type, was taken on the desert on the Arizona side.

The salient fact shown by this comparative examination is that *in all other characters* the specimens aberrant in color of wings and tail, are perfectly typical of *chrysoides* (that is, of its subspecies *mearnsi*). None of the phenomena consequent upon hybridization is evinced in other particulars, such as general size, proportional dimensions, extent of dorsal barring, colors of body and head. In all these characters there is no nearer approach of the red-shafted *chrysoides* to *collaris*, than of the yellow-shafted *chrysoides*.

My conclusion is that the strain of *chrysoides* occurring at the present time in the lower Colorado Valley shows proneness to replacement of yellow by red, without there having been any interbreeding with another species. This may be accounted for chemico-physiologically, as in the case of the linnet of the Hawaiian Islands, where, however, the change has been from red to yellow. (See Grinnell, 1911, p. 191.) According to this idea there has been some cause, germinal or somatic, affecting the oxidation of the basic chromagen, so that in the critical instance the process is going beyond the stage of yellow-production and reaches the red-production stage. The phenomenon at the present time may be purely sporadic; on the other hand it may be an incipiency of a character which, beginning in this center of differentiation, may become fixed and heritable over a larger area, thus constituting the arising of a new species. The flickers collected were only a few out of the large population which probably occupies the extensive tract of sagnaros widening out to the eastward of the river in Arizona. Observation in the same region at successive times in the future will afford data indicative of the real significance of the phenomenon.

It is quite evident that the aberrant examples described by Brewster and by Swarth from central Arizona, as referred to above, are of the same nature as the Colorado Valley specimens. The chances are that they were not hybrids. So far as shown by the literature at hand, no unquestioned hybrids have been found between *chrysoides* (or any of its subspecies) and *collaris* or *cafer*.

MEASUREMENTS IN MILLIMETERS AND COLOR FEATURES OF *COLAPTES CHRYSOIDES MEARNSI* FROM THE COLORADO VALLEY

No.	Sex	Wing	Tail	Culmen	Dorsal barring	Color of lower surface of wings and tail	Whole top of head to level of eyes	Throat, fore-neck and sides of head
12761	♂	152	100	40	barely indicated	chrome[2] yellow	bright cinnamon	clear gray, no. 9
12762	♀	145	87	35	distinct but reduced	pale coral red	bright cinnamon	clear gray, no. 9
12763	♂	147	91	35	slightly indicated	pale saturn red	bright cinnamon	clear gray, no. 9
12764	♀	149	88	34	well-defined though narrow	pale coral red	bright cinnamon	clear gray, no. 9
12765	♀	142	93	36	well-defined though narrow	pale coral red	bright cinnamon	clear gray, no. 9
4328[1]	♀	154	94	38	narrow but distinct	chrome yellow	bright cinnamon	clear gray, no. 9
4329[1]	♀	147	91	37	well-defined though narrow	chrome yellow	bright cinnamon	clear gray, no. 9

[1] Cooper's Fort Mohave specimens.
[2] Color names from Ridgway's *Nomenclature of Colors*, 1886.

MEASUREMENTS IN MILLIMETERS AND COLOR FEATURES OF *COLAPTES CAFER COLLARIS* FROM THE COLORADO VALLEY

No.	Sex	Wing	Tail	Culmen	Dorsal barring	Color of lower surface of wings and tail	Top of head between lighter superciliary areas	Throat, fore-neck and sides of head
12756	♀	161	110	37	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12757	♂	165	108	39	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12758	♂	161	109	—	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12759	♂	165	111	41	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12760	♂	170	113	38	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6

Phalaenoptilus nuttalli nuttalli (Audubon)
Nuttall Poor-will

Phalaenoptilus nuttalli nitidus Brewster
Frosted Poor-will

Poor-wills were first noted the evening of February 28 at Mellen; then March 3, at The Needles; thenceforth at every one of our stations all the way down the river to Pilot Knob, May 12. The mellow call was heard practically every night when the wind was not blowing. As with the nighthawks, the poor-wills appeared to spend the day out on the desert. One individual was flushed near Ehrenberg from the stony surface of a wash in the shade of a palo verde. In the evening the birds appeared at dusk in the river bottom, alighting in characteristic fashion on spaces of bare ground or in roads, not infrequently on mud bars in the river, or skimming low over the water itself. Their proneness to alight on the wet mud at the edge of the water was evidenced by the packed balls of mud firmly dried on the toes of several of the birds shot. In the evening of April 19, eight miles east of Picacho, fully a dozen poor-wills were observed. There was a lot of broken-down fencing close to the river near our camp at this point; the birds congregated here as a basis for foraging and consociating, resting on the posts as well as on the prostrate poles, evidently in preference to alighting on the sticky mud of an overflow depression on the one hand or the river margin on the other.

The series of eighteen specimens of this bird secured at once aroused inquiry because of the large range displayed in size and pattern of coloration. Even in the field, as the specimens were collected, conspicuous differences were noted and the suspicion aroused that really two subspecies were represented, one being the resident breeding form, the other a winter visitant. The first clue to discrimination came through observing the state of activity of the reproductive organs. Of two birds shot the same evening at Riverside Mountain, one, no. 12780, with testes small, was relatively large, dark, and coarsely marked; the other, no. 12781, with testes very large, was small in general size, narrow-barred, and notably pale. In five other birds, field examination showed the same relative state of affairs (see accompanying tables). It is of course regrettable that state of reproductive activity was not recorded of all the poor-wills taken.

The seven birds, dissected in the field by the writer, would seem to provide adequate basis for the conclusion that two races were repre-

sented, in spite of the fact that of the remainder of the series it is difficult to allocate certain examples with one or the other category. This has finally been done, however, as shown in the tables. The first character employed for separation, and the only one holding throughout the present series, is the style of black marking on the medial scapulars. In the resident form, for which I am using the name *nitidus*, these markings are narrow and more V-shaped or hastate; in the presumably migratory form, which I am calling *nuttalli*, these markings are broad, sagittate to rhomboid. I am inclined, however, to believe that this character, like the others pointed out beyond, will be found to fail in some cases; for a skin at hand from the Huachuca Mountains, Arizona (no. 10324), is otherwise good *nitidus* as here understood, but the scapular markings are broadly rhomboid. In the Colorado series, believed to represent two forms, any of the remaining characters are not separately diagnostic in every case. But the series is found divisible with fair precision as indicated in the tables, by an aggregate of characters.

Besides the scapular marks above specified, the black barring across the primaries averages narrower in *nitidus* than in *nuttalli*, and their transverse trend is zigzag in the former, more squarely defined in the latter. The transverse dark barring on the posterior lower surface averages narrower again in *nitidus*, coarser in *nuttalli*. The ground-color, whitish or hoary, is not only more extended in *nitidus* but of a clearer white tone. In general size *nitidus* is distinctly the smaller, and it appears to have a more rounded wing, indicative of less extended migratory flight.

While in each of these characters variation leads from one extreme to the other, there are clearly two modes. The theory suggests itself as accounting for this, that there are two unstable phases in the poor-will, irrespective of locality, sex or age, a condition which has been verified in the case of certain owls. But the facts as here presented militate against either that idea or the contention that the paleness develops with individual senility. All the above characters are paralleled in such birds as are represented by races occupying the deserts on the one hand and the more northern and less arid regions on the other. Some of the *nuttalli* examples are precisely like poor-wills in the Museum collected from Humboldt County, Nevada. No skins examined from anywhere north of the Colorado Valley show characters of *nitidus*.

The inference is that the *nuttalli* of the Colorado Valley are winter visitants from the Great Basin region. That these, however, are identical with typical *nuttalli*, described from South Dakota (according to A. O. U. *Check-List*, 1910, p. 197), is problematical. I have had no opportunity for comparison of relevant material. Neither is there assurance that the Colorado Valley *nitidus* is typical of the form bearing that name and described from the Nueces River, southern Texas (Brewster, 1887, p. 147). In the original description of the latter, restriction of dark markings and general paleness are emphasized characters, which are in accord with the Colorado Valley *nitidus*. Ridgway (1887, p. 588) adds the character of small size. The difference in facial mottling, mentioned by both of the authors just cited, is not clearly in evidence in the Colorado Valley material.

It is to be remarked that *Phalaenoptilus nuttalli californicus*, represented by specimens from central and southern California west of the desert divide, is well differentiated from both of the forms here pointed out. Three races of the poor-will thus occur within the state of California, and as there are good grounds for believing that *P. n. nuttalli* summers east of the Sierran divide in northeastern California, all three probably breed within the limits of the state.

In this connection sixty-seven adult-plumaged poor-wills have been examined.

LIST AND DIMENSIONS IN MILLIMETERS OF *PHALAENOPTILUS NUTTALLI NUTTALLI* FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	9th primary exceeds 10th by	Wing formula
12780	♂[1]	Riverside Mt., Calif. side	Mar. 18	145.5	89.0	5.5	9–8–10–7
12785	♂[1]	Opposite Cibola, Calif. side	Apr. 2	140.0	88.2	too worn	.....
12791	♂[1]	8 mi. E. Picacho, Calif. side	Apr. 18	136.3	84.0	too worn	.....
12777	♂	Chemehuevis Val., Calif. side	Mar. 10	133.8	80.3	4.7	9–8–10–7
12788	♂	10 mi. S. Cibola, Ariz. side	Apr. 7	142.4	82.0	too worn	.....
12783	♂	Ehrenberg, Ariz. side	Mar. 27	144.3	82.0	7.4	9–8–7–10
		Average of the males,		140.4	84.2	5.9	
12790	♀[1]	8 mi. E. Picacho, Calif. side	Apr. 18	138.1	82.5	7.5	9–8–7–10
12789	♀	20 mi. N. Picacho, Calif. side	Apr. 10	144.2	82.5	7.1	9–8–7–10
12784	♀	Opposite Cibola, Calif. side	Mar. 31	142.7	85.6	8.7	9–8–7–10
12779	♀	Riverside Mt., Calif. side	Mar. 18	139.0	80.0	4.7	9–8–7–10
12776	♀	Chemehuevis Val., Calif. side	Mar. 10	138.0	85.0	5.2	9–8–10–7
12793	♀	5 mi. N. Laguna, Ariz. side	Apr. 22	141.0	81.2	5.5	9–8–7–10
		Average of the females		140.5	82.8	6.4	
		Average of the 12 specimens		140.4	83.5	6.2	

[1] Dissection showed reproductive organs to be inactive.

LIST AND DIMENSIONS IN MILLIMETERS OF *PHALAENOPTILUS NUTTALLI NITIDUS* FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	9th primary exceeds 10th by	Wing formula
12781	♂[1]	Riverside Mt., Calif. side	Mar. 18	132.8	79.8	7.9	9–8–7–10
12786	♂[1]	Opposite Cibola, Calif. side	Apr. 2	135.4	82.8	6.0	8–9–7–10
12787	♂	Opposite Cibola, Calif. side	Apr. 3	133.1	83.7	5.7	9–8–7–10
12778	♂	Above Bill Williams River, Ariz. side	Mar. 14	140.3	82.1	10.0	9–8–7–10
		Average of the males,		135.4	82.1	7.4	
12782	♀	Above Blythe, Calif. side	Mar. 23	130.7	77.3	5.2	9–8–7–10
12792	♀[1]	8 mi. E. Picacho, Calif. side	Apr. 19	131.9	77.0	6.5	8–9–7–10
		Average of the females,		131.3	77.1	5.8	
		Average of the 6 specimens,		134.0	80.3	6.9	

[1] Dissection showed reproductive organs to be much enlarged.

Chordeiles acutipennis texensis Lawrence

Texas Nighthawk

First seen on March 9, on the California side in Chemehuevis Valley—one individual at dusk flying north. Next, March 27, on the Arizona side at Ehrenberg. Thereafter common at all stations, appearing each evening at dusk over the river and its flood plain. Not observed anywhere in the riparian strips during the day, but often flushed from the desert floor, usually from the scanty shade of a creosote bush.

A specimen shot on the Arizona side five miles above Laguna, April 24, had a spine-cushion of a cactus firmly stuck into the right carpal joint. This impediment, evidently picked up from the ground some time previously, had proven so serious a handicap as to result in the bird's emaciated bodily condition. It would probably have resulted finally in the death of the bird, as the spines were deeply imbedded in the tissues. Accidents of this sort may not be infrequent and thus introduce an additional factor into the economy of desert bird-life.

Near Pilot Knob, May 8, a Texas nighthawk was flushed from its complement of two fresh eggs. These lay on bare gravel between pebbles in the shade of a creosote bush on the hot glaring mesa. They are of the size and type of coloration usual with this species.

The eight skins preserved, nos. 12766–12773, show no peculiarities as compared with specimens from the San Diego and San Joaquin

districts of California. It is quite possible that the species is a comparatively recent invader of the latter regions, hailing originally from the more arid deserts, with which its pale coloration would appear to associate it most closely.

There are in the Museum two skins (nos. 4185, 4186) taken by J. G. Cooper at Fort Mohave, April 23 and May 23, 1861.

Chaetura vauxi (Townsend)

Vaux Swift

Appeared as a migrant. First seen at Potholes, April 29, two individuals; next, one, on the following day, four miles south of Potholes. Very many were observed May 4 along the California side five miles northeast of Yuma; these were flying in a general northerly direction across the woods and river, irrespective of the local trend of the latter. May 5 a flock was seen at the mouth of the Gila, near Yuma. May 9 the last was seen, a single individual among cliff swallows near Pilot Knob. Two specimens secured, nos. 12774, 12775.

Aëronautes melanoleucus (Baird)

White-throated Swift

Observed as follows: March 1 and 5, on the Arizona side among The Needles, seen to enter a slanting crack in the face of the cliff; April 4, on a precipitous mountain peak about five miles west of the river opposite Cibola, seen to enter and leave a crevice in the rock wall; April 19, eight miles east of Picacho, flying overhead; May 2, four miles south of Potholes, overhead. Not more than two individuals were noted at any of the above localities.

Archilochus alexandri (Bourcier and Mulsant)

Black-chinned Hummingbird

First noted March 3, one of each sex, on the California side opposite The Needles; next March 7, several on the Arizona side at the foot of The Needles. Here they were feeding about the flowering bushes of *Lycium andersoni*. Noted on the California side in the lower Chemehuevis Valley, March 9, one specimen; several on the Arizona side above Bill Williams River, March 13 and 14; several at River-

side Mountain, March 17 to 21. At our station above Blythe, March 22 and 23, this hummer was for the first time numerous, both males and females occurring along the desert edge of the riparian bottom, feeding among bushes of *Lycium andersoni*. At Ehrenberg the last week of March and opposite Cibola the first week in April, the species was abundant in the desert washes, feeding about the profusely blossoming palo verdes. Noted at all stations below the latter point, though in lesser numbers.

The males were more seldom seen, and the females became closely restricted to the willow strip along the river, in which association we were convinced that this was the only species of hummingbird breeding. The males were not seen in the willows, but only in the mesquite association and up the desert washes. The females foraged everywhere except on the desert mesa, but nested exclusively in the willows. Nest-building was in progress April 12, on the California side twenty miles north of Picacho. Nests, each with two small young, were found April 18 and 20, on the same side eight miles east of Picacho. Many full-grown young-of-the-year were feeding about the lavender flowers

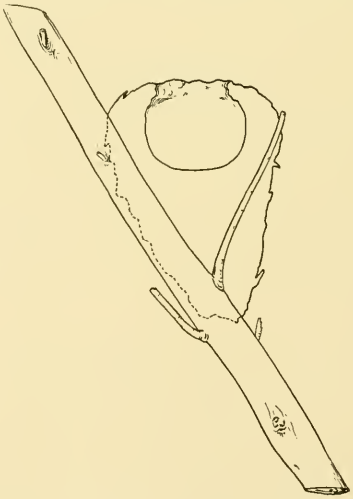


Fig. 6. Vertical sectional diagram of nest (no. 769) of *Archilochus alexandri*. Note position as regards supporting stalk, and construction of rim (see text, p. 145). × ⅔.

of ironwoods in washes near Pilot Knob, May 13. The breeding season of this hummingbird in this region is thus definitely indicated and shows itself to be just about one month earlier than on the Pacific slope of southern California.

Of the nests above referred to, one was placed eight feet above the ground on a dead willow twig, in a close-set grove of tall willows. The other was four feet above the ground on a slanting dead stalk of arrowweed beneath a large spreading willow. In structure and composition the nests are of the compact type peculiar to this species as compared with those of the Costa. The body of the nest in one (no. 769) is closely felted cottonwood and willow down. The whole outer surface is closely beset with small yellow and green leaves gathered where dried, on the lower portions of arrowweed stalks, and attached with web. A conspicuous feature is the extreme constriction of the rim, as shown in the accompanying sectional diagram (fig. G). Even if the supporting stalk were bent down to a horizontal position, there would be no likelihood of eggs or young falling out, because of the depth of the cavity and narrowing of the neck at the top. This maximum in complexity of construction, accompanying, as it does, situation upon a tall, slender, and easily swayed stalk, shows marked adaptation in the habits of the bird to meet the special conditions imposed by its nesting site.

The four newly hatched young (numbered 13985, 13986) are of interest in one particular in that they show a double row of down filaments along the dorsal tract, thus indicating the presence of a partial natal plumage, which plumage has been supposed to be unrepresented in the Trochilidae.

Eighteen adult examples of the black-chinned hummingbird were preserved, nos. 12794–12811.

There is also in the Museum a skin (no. 5882) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 20, 1864.

Calypte costae (Bourcier)

Costa Hummingbird

First seen February 26, a male flying northward near Mellen, Arizona. Next noted March 1, opposite The Needles, and for the *andersoni* which were at this time profusely laden with flowers. A succeeding week very common along ravines on both sides of the river at The Needles. They were feeding about the spiny bushes of *Lycium andersoni* which were at this time profusely laden with flowers. A

tall-stalked milkweed (*Asclepias subulata*) growing high among the precipitous peaks was also an attraction; so, too, a sage (*Hyptis emoryi*). The latter was about the only shrub growing on the walls of steep-sided gulches at Riverside Mountain, and here two old nests of the Costa hummingbird were found on horizontally projecting or drooping branches of the plant. Another nest found March 16 was five feet above the bed of a wash and contained two eggs; on the 19th the eggs were hatched.

This hummingbird was pre-eminently a desert species; it was only casually noted even as a forager within the riparian set of associations. It was thus complementary in its local distribution to *Archilochus alexandri*. It was more abundant in the early part of the season than later. This may have been due to local variation in favoring conditions as we traversed the region; or it is quite likely that the males and, as soon as able, the young and females largely departed from the desert floor to seek feeding grounds on the higher desert ranges.

Besides the localities mentioned above, the Costa hummingbird was noted in Chemehuevis Valley, above Bill Williams River, opposite Cibola, twenty miles above Picacho, and at Pilot Knob. At the latter point, May 13, full grown juvenals were feeding about flowering ironwoods.

Seventeen adult specimens of the species were obtained, nos. 12812–12828.

Tyrannus verticalis Say

Western Kingbird

First seen, two individuals, March 24, at Ehrenberg; next, three individuals, March 29, at the same place; thereafter noted frequently at various points down the river. On the Arizona side five miles above Laguna, where there were many dead cottonwoods, many kingbirds were to be seen in pairs May 25; and their behavior led me to suspect them to be about to nest. The same condition held in the river bottom on the California side four miles below Potholes. No actual nests were seen, however. Many individuals believed to be in migration were seen at Pilot Knob, May 12. Seven specimens of this bird were taken, nos. 12829–12835.

There is also in the Museum a skin (no. 4295) taken by J. G. Cooper at Fort Mohave April 25, 1861.

Myiarchus cinerascens cinerascens (Lawrence)

Ash-throated Flycatcher

Our capture of an example of this flycatcher as early as February 19 in a willow tract on the California side five miles below Needles, would appear to indicate that the species winters in the region. This idea is further borne out by Cooper's observation (1870, p. 317) that he encountered an individual at Fort Mohave January 15. On March 8 in the willow groves in Chemehuevis Valley we saw three ash-throated flycatchers; on March 9, two. Thenceforth the species was noted regularly. It was common above Bill Williams River, affecting a tract of mesquites as well as the willows; also at Riverside Mountain and above Blythe. At Ehrenberg, besides scattered individuals, several pairs were encountered March 27 in the saguaro belt back on the mesa; in each case the birds had obvious claims on some old woodpecker hole in a huge cactus trunk. Opposite Cibola and ten miles below Cibola individuals were seen to enter rotted-out cavities in ironwoods.

The species was less common at our stations twenty miles north of and eight miles east of Picacho. But in the saguaro belt on both sides of the river and within five miles above the Laguna Dam the ash-throated flycatcher was one of the characteristic breeding birds. The woodpecker holes in the giant cactuses are pre-eminently suited to these birds as nesting sites. A nest on the Arizona side was chopped out April 21 and found to contain one fresh egg. The nest cavity was five feet above the ground, and was bedded with a mass of burro hair and duck feathers. Another nest, found on the California side, April 23, was twelve feet above the ground in a cavity fourteen inches deep; composed of a closely packed mass of rabbit fur; there were four eggs in which incubation was well along.

Ash-throated flycatchers were further observed, though more sparingly, at our stations at Potholes, four miles south of Potholes, five miles northeast of Yuma, and at Pilot Knob.

A specimen (no. 4293) is in the Museum taken by J. G. Cooper at Fort Mohave April 13, 1861.

Our series of twenty-five specimens (nos. 12836–12860) was secured as a result of an unsuccessful attempt to detect the presence of some one of the Mexican forms which come regularly into southern Arizona. While it is probable that this series includes transient individuals, it is not possible to pick them out, and the majority are, for certain,

breeding birds. I cannot discern in the series as a whole any departure from the characters of *M. c. cinerascens* of the coast slope of California. The accompanying table shows the size and range of variation in certain respects of the Colorado Valley birds.

MEASUREMENTS[1] IN MILLIMETERS OF A SERIES OF *MYIARCHUS CINERASCENS CINERASCENS* TAKEN IN THE COLORADO VALLEY FROM NEEDLES TO YUMA, FEBRUARY 19 TO MAY 9, 1910

Males					*Females*				
No.	Wing	Tail	Culmen	Width of bill at nostrils	No	Wing	Tail	Culmen	Width of bill at nostrils
12837	103.0	95.0	17.8	7.6	12836	93.0	87.0	16.4	8.0
12838	100.0	91.5	17.2	7.9	12846	92.5	85.5	17.0	7.7
12839	99.3	92.5	17.4	7.7	12847	93.5	85.0	16.7	7.1
12840	101.3	92.0	17.8	8.0	12849	97.7	89.3	17.2	7.7
12841	102.5	93.0	16.9	7.6	12852	92.2	82.7	17.5	7.4
12842	98.4	89.0	18.2	7.5	12853	94.0	84.7	16.9	8.0
12843	99.5	90.0	18.0	7.7	12855	91.7	83.8	17.6	7.2
12844	101.6	95.0	18.7	8.1	12856	92.3	85.3	17.8	7.7
12845	102.3	92.3	18.0	7.8	12857	96.0	88.4	18.4	7.8
12848	98.4	89.2	17.5	7.7	12859	94.0	88.5	17.8	7.3
12850	101.6	91.9	18.0	7.6	12860	95.5	87.2	18.0	7.2
12851	98.0	92.0	17.2	7.4	Average	93.8	86.1	17.4	7.6
12854	98.5	92.2	18.2	8.3	Maximum	97.7	89.3	18.4	8.0
12858	102.0	93.1	19.7	7.4	Minimum	91.7	82.7	16.4	7.1
Average	100.5	92.0	17.9	7.7	Mid-point of Range	94.7	86.0	17.4	7.5
Maximum	103.0	95.0	18.7	8.3					
Minimum	98.0	89.0	16.9	7.4					
Mid-point of Range	100.5	92.0	17.8	7.8	Variation either side of mid-point	3¼%	3⅜%	5¾%	6%
Variation either side of mid-point	2½%	3¼%	5%	5¾%					

[1] See text under *Molothrus ater obscurus*, p. 157.

The table shows also the decided sexual difference in size in this species, and further that in both sexes there is greater variation in the size and relative narrowness of the bill, than in wing and tail length. Incidentally it would appear that females are subject to greater variation than males. All of the birds whose measurements are presented are comparable as regards stage of plumage wear and age; they are, at youngest, birds of the previous year.

Sayornis sayus sayus (Bonaparte)

Say Phoebe

In February and early March this species was met with in small numbers out on the desert mesas as well as on the lower slopes of the hills. But it was not found in the wooded bottom lands of the broader valleys nor along the river banks except where the rocky hills abutted close upon the water. The bird was evidently wintering in the region, as the several individuals seen in the town of Needles upon our arrival there, February 15, were much smoke-begrimed, showing that their plumage had been exposed to the local conditions for some considerable time.

The Say phoebe was further noted at Mellen, among The Needles, and above Bill Williams River, on the Arizona side; and, on the California side, opposite The Needles. As the season advanced this species was met with only sparingly and in the vicinity of nesting sites. A pair was noted at Ehrenberg March 28, flying about some adobe ruins. On the California side opposite Cibola, April 3, a pair was found in a steep-sided ravine two miles back from the river. A last year's nest, of usual construction and containing one dried egg, was found on a narrow shelf of rock itself a part of an overhanging conglomerate wall. A single bird was noted ten miles south of Cibola near some adobe ruins. Another was taken April 12 among the hills twenty miles north of Picacho. The species was last seen at Potholes, where one was observed on a telephone wire near the head works of the canal, April 29. Seven specimens were preserved, nos. 12861–12867.

Sayornis nigricans (Swainson)

Black Phoebe

Met with only during the early part of the season, and only close along the river, where it was fairly common. Favorite perches were tips of snags on mud bars, or twigs of trees fallen over into the river through undercutting of the bank. The species was noted at Needles, five miles below Needles, at Mellen, on both sides of the river in the vicinity of The Needles, in Chemehuevis Valley, at Riverside Mountain, and at Ehrenberg. One, the last noted, was seen on the California side opposite Cibola, April 5. As far as it goes, the evidence would seem to show that the black phoebe is only a winter visitant in the Colorado Valley. Five specimens were preserved, nos. 12868–12872.

Nuttallornis borealis (Swainson)

Olive-sided Flycatcher

One seen May 6 perched at the top of a willow stub in bottom land on the California side near Pilot Knob. Two seen near the same place, May 10. Undoubtedly migrants.

Myiochanes richardsoni richardsoni (Swainson)

Western Wood Pewee

First observed April 20, when a male was secured on the California side, eight miles east of Picacho. Next noted at Potholes, April 29; thenceforth in small numbers nearly every day, at the stations four miles south of Potholes, five miles northeast of Yuma, and at Pilot Knob. Most numerous at the latter point, May 6 to 12, where as elsewhere they were closely confined to the willow bottoms. Evidently only a migrant through the region. Eight specimens taken, nos. 12918–12925.

There are also in the Museum three skins (nos. 4305–4307) taken by J. G. Cooper at Fort Mohave, May 21 and 22, 1861.

Empidonax difficilis difficilis Baird

Western Flycatcher

First noted April 3, on the California side opposite Cibola, observed almost daily thereafter throughout the trip, the last being seen the day we left, May 15. Still, there is no evidence to indicate that the species remains to breed anywhere in the region. The migration appeared not to have reached its height until the second week of May when, in the willows of the bottom lands on both sides near Pilot Knob, western flycatchers were continually in evidence, through their unmistakable notes.

The fourteen skins preserved (nos. 12896–12909) are representative of the following localities: Arizona side: ten miles below Cibola, five miles north of Laguna; California side: opposite Cibola, eight miles east of Picacho, four miles south of Potholes, Pilot Knob. One specimen (no. 12909) is aberrant in that the lower surface has a peculiar blanched appearance, the sides of the belly and crissum being

distinctly whitish. This results in a casual similarity to *E. trailli;* all of the other characters are normal for *difficilis,* however.

There is also in the Museum a skin (no. 4302) taken by J. G. Cooper at Fort Mohave, May 20, 1861.

Empidonax trailli trailli (Audubon)

Traill Flycatcher

First detected April 28 and 29, when several were discovered in a tract of willows on the California side within a mile below Potholes. There were several of the birds, keeping in the upper foliage of the trees on ground overflowed from the adjacent canal to a depth of two feet or less.

On the same side of the river five miles northeast of Yuma several Traill flycatchers were observed May 4 and 5 close along a rapidly filling slough lined with willows. On both sides of the river in the vicinity of Pilot Knob the species was frequently observed up to the date of our departure, May 15. The birds were never detected away from dense willow growths close to the water, just such a type of locality as is chosen elsewhere for nesting ground. This fact and the behavior of the birds led me to believe that they would nest in the vicinity. If so, this is the only *Empidonax* to breed in the lower Colorado Valley. Two specimens taken, nos. 12910, 12911, both males, are quite like more northern and western breeding birds.

Empidonax hammondi (Xantus)

Hammond Flycatcher

First observed April 3, on the California side opposite Cibola; next April 6, at the same place; thereafter almost daily all along down the river, usually in the mid-branches of large willows. Thirteen specimens taken (nos. 12883–12895) from: Arizona side: ten miles below Cibola; California side: opposite Cibola, twenty miles above Picacho, eight miles below Picacho, Potholes, Pilot Knob. At the latter point the species was noted up to and including May 11. It appears that the species is only a transient through the region.

Empidonax wrighti Baird

Wright Flycatcher

In only one instance was the presence of this species ascertained, and the specimen secured happened to be the first *Empidonax* taken: no. 12873, male, shot from the upper branches of a willow in the then leafless first-bottom timber, on the California side, five miles south of Needles, February 19.

In spite of the largely increased extent of material illustrating this genus, the relative characters of *Empidonax griseus*, *Empidonax wrighti*, and *Empidonax hammondi* remain somewhat subtle. It would seem that *wrighti*, as I now recognize it, is much less common in the southwest even as a transient than formerly supposed, since out of the thirty-nine examples of the genus taken by our Colorado expedition but one is referable to *wrighti*.

To show upon what characters I base the discrimination of the *wrighti* example in the present case, a comparison with a picked average specimen of *hammondi* and of *griseus* is here given. All are males of apparently equal age and stage of plumage wear, this being very slight. The color differences are minute: *hammondi* is slatiest, *griseus* ashiest, *wrighti* intermediate; *wrighti* is greenest dorsally and pectorally; the outer web of outer tail-feather is distinctly white nearly to its tip in *griseus*, grayish white in *wrighti*, and but slightly paler than rest of feather in *hammondi*. The lower mandible is entirely blackish brown externally, in *hammondi*, dull or lighter brownish in *wrighti*, while in *griseus* it is blackish brown at tip and abruptly straw yellow for its basal two-thirds, brightest along the rami.

COMPARATIVE MEASUREMENTS IN MILLIMETERS OF THREE CLOSELY RELATED SPECIES OF *EMPIDONAX* OCCURRING TOGETHER IN SPRING IN THE COLORADO VALLEY

	No.	Sex	Wing	Tail	Tarsus	Exposed culmen	Bill from nostril	Width of bill at base	Depth of bill	Width of outer web of outer tail-feather, widest portion	Interval between tips of lateral and central rectrices in closed tail
E. hammondi	12894	♂	69.3	56.1	15.0	8.8	7.0	5.4	3.3	7.6	4.2
E. wrighti	12873	♂	71.0	61.8	18.4	10.1	8.1	6.0	3.9	8.3	3.5
E. griseus	12879	♂	72.0	59.2	18.8	12.9	10.0	6.5	4.6	8.6	0.9

The above are the measurements and features of coloration which I find of diagnostic value, in discriminating these three flycatchers. They apply satisfactorily to the transient flycatchers of Arizona and California. But the breeding ranges of these forms west of the Rockies are still imperfectly made out and there is undoubtedly extensive confusion in the literature.

Empidonax griseus Brewster

Gray Flycatcher

With very little doubt this flycatcher is a winter visitant; but it was nowhere common. The first one noted was shot February 22, on the California side five miles below Needles. The next was secured March 10, also on the California side, in Chemehuevis Valley. Three were taken on the California side near Riverside Mountain; two on the same side opposite Cibola; and two on the Arizona side ten miles below Cibola. The last two were taken April 6 and 7. Nothing more was seen of the species after the latter date. Of the nine examples secured by us (nos. 12874–12882) all are males. This may be indicative of separate areas of wintering for the two sexes, or at least that those individuals wintering farthest north are males.

Two specimens (nos. 4300, 4301) taken by J. G. Cooper at Fort Mohave, April 11 and 27, 1861, are also males.

Pyrocephalus rubinus mexicanus Sclater

Vermilion Flycatcher

An adult male seen at Needles, California, February 14. A few, not more than six in all, noted March 27 to 29 in the vicinity of Ehrenberg, Arizona, where they remained in the sparse mesquite growth at the margin of the bottom farthest from the river. Fairly common April 1 to 5 on the California side opposite Cibola, where closely confined to a narrow strip of mesquite close to the river and along a lagoon. Here a nest was found, April 2, containing three eggs in which incubation was far advanced. It was fifty-four inches above the ground, saddled on the bare forking branch of a dead mesquite standing in an open area thirty-five yards from the river bank.

The nest (no. 767) is slight in bulk, but firmly constructed, mainly of straight short dry twigs held together and to the large supporting

branches with much cobweb; the rather shallow cavity (48 mm. wide by 17 deep) is lined with plant fibers, a few horse and cow hairs, and, most liberally, with down feathers from the desert quail. In spite of the absence of foliage on the tree, the nest was difficult to see even from a distance of fifteen feet, because of its small height above the branches on which it rested, and because its outer surface of gray twigs blended admirably with the striately shredded bark of the dead branches. One large branch extended above the nest, and gave partial protection from the sun, and certain other small branches may have helped some; but the sitting bird must have been compelled to endure the direct and intense sunshine a good part of the day. The nest was discovered only by flushing the bird, which sat very closely, and returned promptly when the intruder left the immediate vicinity Only the female was seen on or close to the nest. The far more brilliantly colored male remained at a distance of twenty to fifty yards from the nest, selecting conspicuous perches on dead mesquites, from which it sallied forth after passing insects in ordinary flycatcher fashion. It sang musically early in the morning before sunrise, the song resembling somewhat that of the black phoebe, though of greater length and not so loud.

The nest and pair of birds were finally collected. The abdominal surface area of the female was found to be conspicuously modified for incubatory function, the skin being greatly thickened owing to the subcutaneous vascular development. The male had no such feature. This must have been an exceptionally early laying for the species in this vicinity, as other females taken showed no signs of breeding.

The vermilion flycatcher was next noted on the Arizona side five miles above Laguna, where it was fairly common on overflow land among drowned and living cottonwoods and dead mesquites. On the California side, four miles below Potholes, the species proved to be one of the most numerous of the birds present. Here the valley widens out; much land is being reclaimed for farming, and intersecting irrigation ditches supplied from the Laguna Dam conduct water throughout the region. There is much waste land as yet, and burning has killed many of the cottonwoods. In this sort of locality the vermilion flycatchers were found to be far more numerous than anywhere else; it would appear that here is a native bird of the Colorado Valley which will greatly augment in numbers with the settling of the region.

A peculiarity of the bird which impressed me was that by apparent preference it avoided green foliage, almost invariably perching on

dead branches or exposed tree-tips, where the brilliant colors of the male rendered each individual most conspicuous. Yet this same sort of perch, because of its being a good vantage point from which to get the widest survey for passing insects, was also preferred by the other flycatchers, such as wood pewees and western kingbirds. No instance came under my observation of the conspicuousness of the male vermilion flycatcher causing it to be molested save by human hunters.

A half-grown juvenal was taken May 2 at this last station. The species was seen nowhere else than as above stated. Eighteen specimens were secured (nos. 12938–12955).

Corvus corax sinuatus Wagler

Western Raven

Ravens were to be seen at practically every point of observation along our route from Needles to Pilot Knob. They were always noted singly or paired and were usually quiet. No young of the season were observed up to the time of our departure from the region. Ravens came to notice most frequently along the river as we floated down the swift current. Our boat was sometimes quietly carried into close proximity to an unwitting raven as it foraged for fish on some sand bar.

At a heronry on the California side, ten miles below Ehrenberg, a pair of ravens was observed circling close over some nests which had just been deserted by the startled herons. Nearby, a dead cottonwood stub had under it a number of broken heron egg shells which doubtless betokened a source of the ravens' food supply. The stomach of one of the ravens shot contained only some mammal hair and one spider.

In each of the three ravens secured the "concealed" grayish white of the hind neck is much whiter and more extended than in ravens from California west of the desert divide. In the latter it is ordinarily distinctly light gray; in the Colorado River birds it is so much lighter as to give a first impression of pure white contrasted with the black surface-plumage when the feathers are parted. In fact this impression was so vivid that for a time in the field we thought we had secured examples of *Corvus cryptoleucus*. But comparison of skins shows the concealed white of *cryptoleucus* to be actually much more snowy. And there is, of course, no difficulty in distinguishing *sinuatus* from *cryptoleucus* when measurements are compared, the former being very much the larger (see accompanying table).

The Colorado River ravens, as shown by the accompanying table, are of the usual *sinuatus* dimensions. The whitening of the basal or down portions of the nuchal feathers in desert representatives of the *corax* group would seem to be a modification in the direction of the condition as it finds its extreme in *cryptoleucus*, and probably because of coming under the same conditions. But no use of the feature is apparent.

MEASUREMENTS IN MILLIMETERS OF *CORVUS CORAX SINUATUS* FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	Tarsus	Middle toe and claw	Culmen	Bill from nostril	Gonys	Depth of bill at base
12914	♂	Riverside Mt., Calif.	Mar. 16	440	242	70.0	60.0	74.0	52.5	36.3	25.8
12913	♂	10 m. S. Ehrenberg, Calif.	Mar. 30	414	222	66.8	59.5	69.2	50.1	34.3	25.1
12912	♂	10 m. S. Cibola, Ariz.	Apr. 7	381	224	64.8	61.7	67.4	48.0	33.0	26.2
4367[1]	♀	Fort Mohave, Ariz.	Jan. 6	410	212	64.7	58.2	65.6	45.3	31.9	24.2
4368[1]	♀	Fort Mohave, Ariz.	Jan. 6	423	221	65.8	59.0	68.9	49.0	32.9	25.3

[1] Collected by J. G. Cooper in 1861.

Molothrus ater obscurus (Gmelin)

Dwarf Cowbird

Cowbirds were first seen when we reached Ehrenberg, March 25. Here, on the Arizona side, flocks aggregating approximately one hundred individuals were staying close about the town. They were either roosting quietly in mesquites among the adobe ruins, or flying about in compact, unanimously acting flocks, or feeding in company with other blackbirds in cattle pens. In one case a bunch of fully forty were feeding close together on the ground in a calf corral, all with uptilted tails and quivering bodies, a mannerism peculiar to the species. They were eating millet seeds, and the crops of those taken were crammed with this material. One flock was seen flying north along the California side opposite Ehrenberg. On the same side, opposite Cibola, during the first week of April a number were seen, now in pairs haunting the bottom lands close to the river.

The species was next seen April 17 on the California side twenty miles north of Picacho at the Draper ranch, four individuals; then eight miles east of Picacho, April 20, a small flock. On the Arizona side again, five miles north of Laguna, April 24 to 27, several pairs

were seen among cottonwoods. On the California side, from the vicinity of Potholes south all along the river to the Mexican line, the species was numerous throughout the bottom lands. Here up to May 15 cowbirds were to be seen usually in pairs frequenting the densest willow tracts, as well as foraging on the mud bars at the water's edge. When prospecting in thickets near the ground they were usually quiet and gave the impression of sneaking, as if intentionally planning to avoid observation. But when affecting the taller tree tops and open places, they kept flying about actively, often intently pursuing one another, and giving frequent voice to an attenuated squeal. The species confines itself strictly to the river bottom: none were seen out on the desert, even in flight overhead.

Fifty-three skins of the dwarf cowbird were obtained, nos. 12956–13008.

In addition to these there are in the Museum two skins, one (no. 4347) taken by J. G. Cooper at Fort Mohave, April 4, 1861, and another (no. 5963), of unknown collector, from "Mineral City" (=Ehrenberg), April 20, 1864.

The acquisition of so large a series of *Molothrus ater obscurus* (previously sparingly represented in collections) from so limited an area, warrants a detailed examination of its characters. The fifty-three specimens are all comparable, as far as age is determinable, and are in comparatively unabraded plumage. The variations in measurements are therefore intrinsic, except, of course, for an indefinite but small amount of error which seems unavoidable. Although but four dimensions are presented, it is believed that these are a close index to any other correlated features that could be selected for measurement. And the ones adopted would appear to be capable of more exact determination than, for example, length of body and wing expanse.

The wing is measured, according to prevalent custom, from the bend of the carpus in closed wing to tip of longest primary; but even here a slight error may result from the mode in which the wing has been "set" in drying, that is, according to the sharpness of the *curve* along its outer edge. The tail is measured from the point between the insertions of the median rectrices into the uropygium to the tip of the longest rectrix in "closed" tail; and here too the proximal point from which to measure is not quite satisfactory. The culmen is rather more accurate of measurement in the cowbirds because it is a well-defined ridge coming to an end rather abruptly on the forehead. The depth of bill is most unsatisfactory because of the liability to slight separation

or abnormal closeness of the mandibles incurred in drying, and because of the conical shape of the beak. The method of taking the measurement here presented is to secure with calipers the diameter of the bill from the highest point on the culmen along a line through the nostril. This does not, therefore, take into account the *extreme* base of the lower mandible, where it is difficult to find any constant point from which to measure.

It will be noted from the tables that, in both sexes, the average is practically identical with the mid-point of range; that the wing length is least variable; that males are more variable than females; that the bill of the female is relatively shorter and thicker than that of the male, and its shape is much more constant; that in the male the variation in the shape of the bill involves length much more than depth, so that a wide range in degree of slenderness results, rather than in actual volume; that in matter of general size of body (using the wing and tail length as an index) females are nine per cent smaller than males.

Previously (1909, p. 281) the writer has given a table of measurements of the then available specimens of *Molothrus ater obscurus*. There were eleven males, from Arizona and southeastern California. Comparison with the dimensions of thirty-one other males as here presented shows remarkably close accord in all particulars save one, due to depth of bill being taken to extreme base of lower mandible instead of through nostril. It is of interest to note that among the entire series of fifty-three cowbirds from the lower Colorado River there is not one showing any closer approach to the Nevada form, *Molothrus ater artemisiae*, than in the smaller series above referred to and used originally for comparison. The apparent absence of *M. a. artemisiae* from the Colorado Valley as a migrant is contrary to previous ideas as to its route of migration to and from the Great Basin region. But what other route may be followed is still a matter of conjecture.

As regards color the Colorado series is remarkably uniform, except in one respect: the steely reflections of the dark body plumage in the male vary from deep violet to bronzy. This variation is exhibited similarly in *M. a. artemisiae* and in *M. a. ater*. In *obscurus*, however, the brownness of the head averages perceptibly paler than in the Atlantic race, *ater*. It is in the female that *obscurus* shows marked color characters as compared with *ater;* and this has apparently been overlooked in current descriptive works (as, for instance, by Ridg-

way, 1902, p. 210). The entire plumage in *obscurus* is very much paler than in *ater*. The former is drab throughout, slightly paler ventrally and very much paler, more clay color, on the throat; the narrow dusky shaft-streaks on the dorsum, chest and sides are clearly indicated. The female of the eastern form is dark slaty hair brown with less abruptly contrasted grayish throat.

MEASUREMENTS[1] IN MILLIMETERS OF THIRTY-ONE MALES OF *MOLOTHRUS ATER OBSCURUS* FROM THE LOWER COLORADO VALLEY

No.	Wing	Tail	Culmen	Depth of bill at nostril	Ratio % of depth of bill to culmen
12960	96.8	65.3	15.5	8.5	55
12961	97.8	64.7	15.2	8.7	57
12962	96.5	63.8	16.0	8.3	55
12963	102.3	68.3	15.3	8.6	56
12964	100.7	69.6	14.8	8.2	55
12965	100.4	66.4	16.2	8.4	52
12966	101.0	67.5	16.0	8.5	53
12967	103.3	66.7	16.0	8.8	55
12968	98.7	64.5	15.5	8.4	54
12969	97.3	65.0	15.7	8.0	51
12970	100.9	66.4	16.6	8.4	51
12971	101.4	66.0	16.5	8.7	53
12972	103.0	69.6	15.8	8.5	54
12976	100.0	67.4	16.0	8.4	52
12979	100.8	65.5	15.6	8.3	53
12981	98.5	69.3	16.1	8.6	53
12986	102.6	69.9	16.5	8.5	52
12987	103.7	68.5	15.9	8.4	53
12988	98.9	64.7	15.6	8.0	51
12989	96.7	66.2	16.1	8.2	51
12990	99.8	67.0	16.9	8.3	49
12992	103.1	70.5	17.0	8.4	49
12993	97.4	66.2	17.1	8.2	48
12995	101.3	70.0	17.0	8.2	48
12998	103.2	69.4	16.0	8.0	50
13000	99.4	64.6	17.3	8.6	50
13001	101.1	67.0	16.8	8.1	48
13005	102.5	70.0	15.7	8.4	53
13006	102.0	69.7	17.2	8.1	47
13007	99.1	63.6	16.4	8.3	51
13008	97.0	67.0	16.0	8.1	51
Average	100.2	67.1	16.1	8.4	52
Maximum	103.7	70.5	17.3	8.8	57
Minimum	96.5	63.6	14.8	8.0	47
Mid-point of Range	100.1	67.0	16.1	8.4	52
Variation on either side of mid-point	3.6%	5%	7.4%	4.8%	10%

[1] See text, pp. 157–158.

MEASUREMENTS IN MILLIMETERS OF TWENTY-TWO FEMALES OF *MOLOTHRUS ATER OBSCURUS* FROM THE LOWER COLORADO VALLEY

No.	Wing	Tail	Culmen	Depth of bill at nostril	Ratio % of depth of bill to culmen
12956	90.5	59.6	14.7	8.0	54
12957	91.7	60.3	15.0	8.4	56
12958	89.8	59.9	14.0	8.0	57
12959	91.9	61.3	15.1	8.3	55
12973	88.8	60.3	14.5	7.8	54
12974	89.2	58.0	14.4	7.7	53
12975	89.7	59.7	14.5	8.0	55
12977	92.3	58.6	14.6	7.8	53
12978	89.0	59.7	14.8	7.9	53
12980	91.8	62.0	14.6	8.1	55
12982	89.0	59.5	15.2	8.0	53
12983	91.1	60.3	14.4	7.7	53
12984	91.4	61.6	15.0	8.0	53
12985	92.9	63.7	.....[1]	7.5	....
12991	94.6	65.0	14.9	8.2	55
12994	90.4	62.9	.....[1]	....[1]	....
12996	91.6	59.3	14.8	7.7	52
12997	92.7	62.0	15.4	7.8	51
12999	93.4	63.3	15.0	8.1	54
13002	89.0	59.0	14.7	8.0	54
13003	93.0	59.5	15.0	8.3	55
13004	93.3	59.8	14.9	8.2	55
Average	91.2	60.7	14.8	8.0	54
Maximum	94.6	63.7	15.4	8.4	57
Minimum	88.8	58.0	14.0	7.5	51
Mid-point of Range	91.7	60.8	14.7	8.0	54
Variation on either side of mid-point	3.2%	4.6%	4.8%	5.6%	5.5%

[1] Defective.

Xanthocephalus xanthocephalus (Bonaparte)

Yellow-headed Blackbird

The single specimen secured, an adult male (no. 12915), was shot from a flock of cowbirds at Ehrenberg, Arizona, March 28. No others of the species were seen at that point. But on April 24, on the Arizona side five miles north of Laguna, a male and two females were seen overhead flying south. And on May 5, on the California side four miles south of Potholes, a small flock of yellow-headed blackbirds was seen flying north along the river bank.

There is in the Museum an adult male (no. 4346) taken by J. G. Cooper at Fort Mohave March 31, 1861; and another skin (no. 5959) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 8, 1864. The species is probably a regular winter visitant to the Colorado Valley.

Agelaius phoeniceus sonoriensis Ridgway

Sonora Red-winged Blackbird

First seen March 6, when a large flock was encountered flying north along the Arizona shore at the foot of The Needles. Next noted at Ehrenberg, Arizona, during the week beginning March 24. Here not more than fifteen individuals all told were staying close about the town, associated with the cowbirds and Brewer blackbirds which foraged in the cattle corrals. On the same side of the river, ten miles below Cibola, April 7, four individuals were seen in flight up the river. Several small flocks came to notice at our station on the California side eight miles east of Picacho, April 18 to 20. On both sides of the river above Laguna and at Potholes, April 22 to 29, many were seen, mostly in pairs or small flocks pursuing their way up the river. It was observed in nearly every instance that these presumably migrating birds, instead of taking a more direct route northward up the valley, closely followed the river bank even when through the meandering of the stream this course was sinuous in the extreme.

At Potholes and below, evidence was unmistakable that red-wings were preparing to nest, though no nests had been built as yet up to the time of our examination. At one place in particular, on the California side of the river, about five miles northeast of Yuma, a large colony had evidently settled for breeding purposes. Here in the late afternoon of May 2, on the inside of a large bend of the river, we were afforded opportunity of securing a good series of specimens and of observing the behavior of the birds. The males were by themselves, spaced out, and perched at the tips of willow saplings in an extensive dense tract of these on ground which at a little higher stage of the rapidly rising river would have been wholly inundated. The male birds were singing continually, and displaying themselves conspicuously in short circling flights, but each one behaving independently of any other. The females on the other hand were quietly foraging on the ground in close flocks in a much younger growth of

willow seedlings some three hundred yards off. The inference was that the males had selected the appropriate site for the location of nests, but that pairing off had not yet occurred. Here, as with many other birds of the Colorado Valley, it was evident that nesting time is deferred until the period of highest water, which custom doubtless obviates danger of destruction of nests through flooding. Elsewhere in the Austral zone red-winged blackbirds are caring for broods of young at so late a date as May 2.

The species was common near Pilot Knob flying back and forth overhead, evidently between breeding and feeding grounds somewhere in the vicinity. Nowhere was it seen outside of the confines of the river flood plain, so that the desert mesa forms the practical barrier to its farther spread laterally.

Thirty-three specimens were preserved, nos. 13009–13041.

The red-winged blackbirds of the Colorado Valley show themselves to be markedly different from those of the Pacific slope of southern California. The latter are *Agelaius phoeniceus neutralis* Ridgway; the former are here referred to *Agelaius phoeniceus sonoriensis*, following Ridgway's last diagnosis (1902, p. 337). Although the type locality of *sonoriensis* is stated by Ridgway (1902, p. 338) to be Mazatlan, Arizona had previously been fixed as type locality by Nelson (1900, p. 126), and the A. O. U. *Check-List* (1910, p. 233) further specifies *Camp Grant*, Arizona. I have no Mexican material for comparison.

The Colorado Valley form, as compared with *neutralis*, has the bill in both sexes very much longer and slenderer. In some of the males this feature is extraordinarily pronounced: the culmen, gonys and lateral outlines are all concave, resulting in an acicular sharpness of the bill. An opposite variation, however, leads to a moderately pointed bill in six out of twenty-six males, which can be matched by picked examples of *neutralis*. These *neutralis*-like males are all but one obviously immature. It is possible, of course, that some of these may actually be transient or casual visitants of *neutralis*. But it appears to me now as more likely that they are individual extremes of the locally native form, which in the material at hand varies towards them.

The six females collected are all conspicuously different in coloration, as well as in shape of bill, from *neutralis*. They have the coloration ascribed to *sonoriensis*, the black streaking below being much narrower and more distinctly contrasted against the extended white ground; also dorsally and on the sides of the head the pale edgings

of the feathers are much lighter and more extensive. In the males no color peculiarities are apparent.

There is in the Museum a skin (no. 4350) taken by J. G. Cooper at Fort Mohave, January 13, 1861. It is a male, obviously immature. It has a markedly thick bill and much dark rusty on the back. While probably not referable to *sonoriensis*, I am not able to place it satisfactorily. It possibly represents some northern race which winters in the region.

Sturnella neglecta Audubon

Western Meadowlark

Numerous February 15 to 18 on the first bottom close to the river at Needles, California. Here there had been some attempt to induce the growth of a coarse pasture grass by irrigation, and the resulting cleared field scantily clothed with grass formed the chief local attraction for the meadowlarks. A few were seen February 22 five miles below Needles on a section of mesa by the river. Three individuals were seen on some grass land on the Arizona side, above the mouth of Bill Williams River March 13 and 14; and a lone individual was shot April 22 on the Arizona side five miles north of Laguna. Twelve specimens were secured (nos. 12926–12937), all but one near Needles.

There is in the Museum a skin (no. 4359) taken by J. G. Cooper at Fort Mohave January 1, 1861; and another, without date, from "Mineral City" (=Ehrenberg) taken by W. W. Holder.

Icterus cucullatus nelsoni Ridgway

Arizona Hooded Oriole

Common and breeding about the site of the old Hanlon ranch on the California side near Pilot Knob. Here these birds affected primarily the large date palms which afforded characteristic nesting sites. One nest was noted suspended in a mistletoe clump in the cottonwood above the ruins of the American Girl pump. One hooded oriole was discovered far up a wash on the mesa, sipping nectar in company with hummingbirds in a profusely blossoming ironwood. Six of these orioles were secured May 6 to 14, nos. 13055–13060. Elsewhere the species was observed twice on the Arizona side, one seen April 26 five miles north of Laguna, and one heard April 9, ten miles below Cibola; and once on the California side, one heard April 11, twenty miles north of Picacho.

Icterus bullocki (Swainson)

Bullock Oriole

Nests of this species were conspicuous in the taller willows early in the season while the trees were yet leafless, all along the river from Needles down. The first birds to appear were noted on the California side opposite Cibola, April 5. There were five of them, all males, feeding about the blossoms of palo verde trees. From this date on, almost daily, and at every station, the species was noted in increasing numbers, until at Potholes the last of April, and elsewhere down the river to Pilot Knob, this was one of the numerous and characteristic birds of the willow-cottonwood association. Fourteen examples were preserved, nos. 13041–13054. Another specimen in the Museum (no. 4342), an adult male, was taken by J. G. Cooper at Fort Mohave April 3, 1861.

Although there are doubtless breeding individuals among these, as well as probable transients, I am unable to find any differences by which the Colorado Valley birds may be distinguished from those of western California or northern Nevada.

Euphagus cyanocephalus (Wagler)

Brewer Blackbird

Common about the town of Needles, California, February 15, where they were foraging indifferently along the railroad tracks and in the streets. Very many were seen similarly in the town of Parker, Arizona, March 16. Small flocks, aggregating about forty individuals, were noted at Ehrenberg, Arizona, March 24 to 29, and two secured (nos. 12916, 12917). Here the birds were usually mingled with the flocks of cowbirds feeding in chicken yards and cow pens.

There are four skins in the Museum (nos. 4355–4358) taken by J. G. Cooper at Fort Mohave January 4, 1861. Evidently a winter visitant in the Colorado Valley.

Carpodacus mexicanus frontalis (Say)

California Linnet

Locally common all along our route, from Needles to the vicinity of Yuma. Large flocks were foraging over the Sacramento Wash on the Arizona side near Mellen the last week in February. Elsewhere

only small companies were noted, either on the river bottom proper or out on the desert. As the season advanced linnets were more frequently noted in pairs, often along the deep, narrow ravines and precipitous hillsides where the mountains reached the neighborhood of the river. Nests with eggs were found ensconced among the tangled, sharp-pointed twigs of old smoke-bushes on desert washes both at Riverside Mountain, March 18, and Ehrenberg, March 26. Four miles below Potholes the birds were common on the bottom lands, affecting especially those cottonwood trees laden with mistletoe clumps. Five miles above Laguna, a linnet's nest was found in a cavity in the side of the main shaft of a saguaro. Twenty miles north of Picacho a nest with small young was found April 14 on the thorny upper branch of an ironwood.

The series of twenty-eight skins secured (nos. 13061–13088) shows the desert linnets to be in no perceptible way different from those of the coast region of California.

There is in the Museum a skin (no. 4169) taken by J. G. Cooper at Fort Mohave, January 26, 1861.

Astragalinus psaltria hesperophilus Oberholser

Green-backed Goldfinch

More or less common all along the river; evidently resident. First noted on the California side opposite The Needles, several, March 2. On the Arizona side at the foot of The Needles, March 4 to 6, large flocks were congregated in the central portions of extensive dense mesquite thickets where, perched from three to four feet above the ground, they were certainly safe from marauders; here they sang volubly in chorus until dusk settled. During the day they were scattered out over the hills feeding on the flower-heads of *Perityle emoryi*. California side, at Chemehuevis Valley, common, both in the palo verde washes back on the mesa, and in the mesquites and willows near the river; noted similarly, still in flocks, at Riverside Mountain, March 16 to 20, and above Blythe, March 23. On the Arizona side in the vicinity of Ehrenberg there were but few noted, and these only in pairs along the mesa margin of the river bottom; on March 25 two partially constructed nests were found each four feet above the ground in arrowweeds.

Goldfinches of this species were henceforth noted in small numbers as follows: opposite Cibola, ten miles below Cibola, twenty miles north of Picacho, eight miles east of Picacho (full grown young taken), four miles below Potholes and near Pilot Knob (family of young). Twenty-five specimens were taken, nos. 13091–13115. These are identical with the form inhabiting the Pacific slope of California. Of the sixteen males in the series, not one is of the *arizonae* or *mexicanus* type of coloration, that is, with unusual extensions of black in the plumage.

Astragalinus lawrencei (Cassin)

Lawrence Goldfinch

Observed only on the California side at Riverside Mountain, March 17: a flock of eight was discovered in the upper branches of a dead mesquite on the verge of the river bank, singing and calling in characteristic fashion. Two were procured, nos. 13089–13090.

A single specimen (no. 4164) is in the Museum, taken by J. G. Cooper at Fort Mohave January 28, 1861. The species is probably a winter visitant to the Colorado Valley, though not in abundance.

Passer domesticus Linnaeus

English Sparrow

Several dozen were apparently well established in the station park and about the railroad yards of Needles. They had their retreats in the palms and eucalyptus by the station. One lone individual was seen in some willows on the Arizona side half a mile above the railroad station at Mellen, February 24.

Pocœcetes gramineus confinis Baird

Western Vesper Sparrow

Met with in but two places: on the California side, in Chemehuevis Valley, where a specimen, no. 13124, was secured March 10; and on the Arizona side, above Bill Williams River, March 12 and 13, where three specimens were taken, nos. 13125–13127. A few others were seen in the latter locality, where they were all found in a growth of tall coarse grass paralleling the mesquite belt.

There is in the Museum a skin (no. 4155) taken by J. G. Cooper at Fort Mohave, March 6, 1861. This sparrow probably occurs in the region throughout the winter.

Passerculus sandwichensis nevadensis Grinnell

Nevada Savannah Sparrow

Four Savannah sparrows referable to this form were taken: no. 13116, California side, opposite The Needles, March 3 (the only one of the genus seen here); nos. 13117, 13118, Arizona side, above mouth of Bill Williams River, March 13; and no. 13119, Arizona side, five miles north of Laguna, April 22.

Passerculus sandwichensis alaudinus Bonaparte

Western Savannah Sparrow

Five specimens secured, all on the Arizona side: nos. 13120, 13121, above Bill Williams River, March 13, and nos. 13122, 13123, 13128, five miles north of Laguna, April 22. At both places small areas of grassy land on the river bottom back near the mesa afforded the attraction to the species. The last-mentioned specimen is so nearly an intermediate in all characters between *P. s. alaudinus* and *P. s. nevadensis* as to be allocated uncertainly with one or the other. At least six Savannah sparrows were observed in a tract of low herbage lying near the river, five miles northeast of Yuma, May 2; these were the last to be noted.

Chondestes grammacus strigatus Swainson

Western Lark Sparrow

One specimen taken (no. 13129) at edge of bottom near mesa on California side at base of Riverside Mountain, March 17. Not otherwise seen by our party.

Zonotrichia leucophrys leucophrys (Forster)

White-crowned Sparrow

Appeared in the region only as a transient. First noted in Chemehuevis Valley, California side, March 11, when an adult female (no. 13130) in worn winter plumage was shot from a flock of *Z. l. gambeli*. This must have been an exceptionally early arrival, or possibly a stray sojourner through the winter. For no more were identified with certainty until April 11, when a male (no. 13131) was taken on the California side, twenty miles north of Picacho. This bird is in the midst of the first prenuptial molt, as is also another (male, no. 13133)

taken April 18, eight miles east of Picacho. Another (female, no. 13132) taken on the same date and at the same place, and one (male, no. 13134) secured April 21, on the Arizona side five miles north of Laguna, have nearly or quite completed the prenuptial molt (whether first or later, I am not able to judge).

From April 16 to 26 many crown sparrows of this form were observed closely enough to make identity certain. They sometimes formed scattering companies in brush along desert washes; or, in company with *Zonotrichia leucophrys gambeli*, they invaded the mesquite and arrowweed associations nearer the river. None were seen after April 26. It would appear that molting and migration occur simultaneously. Still there is nothing inconsistent with utility in this. For the prenuptial (or spring) molt in this sparrow, as with *gambeli*, is only partial; the flight feathers (primaries, secondaries and rectrices) are not involved, save that, in case any have been lost by accident, new ones grow in at this time.

Zonotrichia leucophrys gambeli (Nuttall)

Intermediate Sparrow

A winter visitant to the region in large numbers, occurring in scattered flocks with greatest frequency along the river, in the mesquite, quail-brush and salt-bush associations. Thence they were to be found up the brushy margins of desert washes at least as far as two miles from the river. Although often found foraging over open ground, these sparrows appeared never to venture so far from dense bushes but that they could on alarm find quick shelter.

In the vicinity of the railroad station at Needles many intermediate sparrows were to be observed at all times of the day foraging over the tracks, often beneath trains, where they appeared to find plenty to eat in the grain and refuse sifting from the cars. These birds had evidently been in the neighborhood all winter, for those shot February 15 and 16 had their plumage begrimed by coal dust to such an extent in some cases that the birds at a distance appeared to be of a uniform deep plumbeous color. No birds of such extraneous peculiarity were observed farther than two miles from the station, perhaps showing habitual close adherence to a local feeding ground selected upon arrival in the fall.

To enumerate localities of occurrence would be to list every place explored along down the river to the collecting station on the Arizona side five miles north of Laguna. By the time we reached this point, April 21, intermediate sparrows had become notably fewer in numbers than immediately before. Still there were several to be seen each day in the arrowweed and willow thickets until the 26th of April, when the last for the season were seen at the same place, and one, a female, taken.

There is in the Museum a skin (no. 4177) taken by J. G. Cooper at Fort Mohave, January 26, 1861.

Of thirty individual specimens shot before the completion of the prenuptial molt, April 15, fifteen are in the brown-and-gray-crowned first winter plumage. As there was, as far as I know, no intention of selecting adults in preference to immatures, these figures probably give an approximate proportion of birds-of-the-year at that season (February 15 to April 15) that is, fifty per cent.

The whole series taken, thirty-four specimens (nos. 13136–13169), serves well to indicate the period occupied in the prenuptial molt. The earliest individual showing molt, adult female, March 27 (no. 13160), shows many new feathers unsheathing in the mid-dorsal and pectoral tracts. An immature of the same date (male, no. 13161) shows a few unsheathing feathers in the mid-dorsal region only. An adult male, April 6 (no. 13162), is well along toward completion of the molt, though many old feathers persist in the capital region. It is of course to be remembered that the prenuptial molt does not involve any of the flight feathers, or, in this species, the wing and tail coverts.

That the molt program is not exactly simultaneous in all individuals is shown by an adult female (no. 13163) taken April 7, in which no sign of molt is apparent. An immature (male, no. 13165), April 10, is in the midst of the molt all over the body. In another specimen (female, no. 13166), April 18, of age not with certainty recognized, the molt is approaching completion. In the remaining three specimens, females, April 20, 24, and 26, feather growth in all the tracts involved is evidently complete, though in each individual a few old abraded feathers still remain in the post-auricular and pectoral regions.

It would thus appear that the spring molt occupies a period of not to exceed twenty-five days. Because of lack of uniformity in date of inception in different individuals or rate of the process, this is probably somewhat more than the time occupied in any one individual. The nuptial dress differs in color from the adult winter plumage in

the clearer ash of the anterior lower parts, in the darker clay color of the flanks, the clearer white of the belly, and the decidedly darker tone of the dorsal streaking, sepia rather than bay.

Spizella passerina arizonae Coues

Western Chipping Sparrow

A single example noted February 20, on the California side, five miles below Needles. On the Arizona side, among the precipitous hills constituting The Needles, a large scattering flock was seen March 5. The birds were foraging among the sparse creosote and *Encelia* bushes on the steep slopes. Thereafter observed on the California side in Chemehuevis Valley, at Riverside Mountain, Blythe, opposite Cibola and eight miles east of Picacho (last April 18), and on the Arizona side above Bill Williams River, at Ehrenberg, and ten miles below Cibola. At all of these points chipping sparrows were frequently met with, either in the bushy ravines among desert hills, or in the brush of the different associations paralleling the river.

I had concluded after seeing none for many days after April 18, that the species had left the region about that time. But as a matter of surprise the species was found once again on April 30 and May 1, on the California side four miles south of Potholes. Here the birds were notably common in the newly settled bottom land characterized by open fields, groves of mistletoe-laden cottonwoods and intersected by irrigation canals. They were in full song, and not in flocks as were the last previously seen, but in pairs, on or near the ground; or the males were singing alone from the bare upper branches of fire-killed trees. The two males shot had their testes greatly enlarged. Thus all the evidence obtained indicates that the species was breeding. Yet no nest was actually found, and the previously unknown occurrence of the species in so low a life-zone brings an element of probability that these individuals were merely tarrying late in the region before leaving for breeding grounds in a higher zone. Moreover the specimens secured differ in neither coloration, general size, nor proportions from breeding birds from the Sierras and northward. The breeding of the chipping sparrow on the lower Colorado is problematical; if a fact, it is a remarkable instance of extreme range of a species through zones from low Lower Sonoran to Canadian, inclusive.

Thirty specimens were obtained by us (nos. 13170–13199) and these show the time of the partial prenuptial molt to occupy some-

what less than one month (in different individuals, March 9 to April 3). The prenuptial molt in *Spizella passerina arizonae* involves in both sexes and apparently all ages, only the capital tracts, and, perhaps in only a few individuals, part of the pectoral region. This is apparently the same condition of affairs found in *Spizella passerina passerina*, of eastern North America, as described by Dwight (1900, p. 199).

Since there are in the Museum two skins (nos. 4160, 4161) taken by J. G. Cooper at Fort Mohave, December 24, 1860, it is evident that the western chipping sparrow passes the winter in the Colorado Valley.

Spizella breweri Cassin

Brewer Sparrow

Since this sparrow was noted as early as February 19, when it was common a few miles south of Needles, a fair inference is that it is a winter sojourner in the region. At any rate, from the above date on until the middle of April, scattering flocks were of frequent note at all our collecting stations, on either side of the river, down to a point on the California side four miles north of Potholes. Here several individuals were seen April 23, the last for the season. As with the chipping sparrow, with which the Brewer sparrow was not infrequently associated, the latter occurred both on the desert uplands and along the river bottom lands. The preferred feeding grounds were probably on the desert, the river being visited only for water.

The series of specimens of *Spizella breweri* secured (nos. 13201–13226) shows that there is a partial prenuptial molt, beginning (as shown by no. 13219, a male) as early as March 11, and continuing at least until March 27. This molt, however, is very limited in extent, involving only the chin and throat in addition to replacement of a part of the feathers of the crown, particularly anteriorly, and the chest. There is a scarcely discernible change in color, resulting in slightly whiter throat and clearer ash and clay color on the crown, certainly not enough to warrant the molt from the standpoint of color significance. Neither does the very small amount of wear which the specimens in hand up to the first of March appear to have incurred, seem sufficient to make a spring molt imperative. Yet the latter would appear the best explanation, restricted area of replacement pointing towards relative importance of the process. A spring molt may have

been more essential as a renewal of worn plumage formerly than at the present time.

Cooper, in at least three places (1861, p. 122; 1869, p. 475; 1870*a*, p. 75) made record of *Spizella pallida* from Fort Mohave. He states that two specimens were secured. In the second citation Cooper even emphasized that it was "not *S. Breweri*" he had. A little later (1870*b*, p. 209) he for the first time gives *Spizella breweri* from Fort Mohave, then without mention of *S. pallida*. It always seemed probable, therefore, that Cooper's "*pallida*," although quoted freely by other authors, was really a misidentification of *breweri*. There are no Cooper specimens of *Spizella* in the Museum of Vertebrate Zoology bearing either name. At my request Dr. C. W. Richmond kindly looked into the matter at the United States National Museum. He writes me that there is a specimen of *Spizella breweri*, so identified by Ridgway and now no. 208619, labeled in Cooper's handwriting "*Spizella pallida*," and taken by him at Fort Mohave, April 2, 1861. This is evidently one of the skins upon which Cooper's record of *pallida* was originally based, so that there is now no doubt but that *breweri* was the species really involved. Needless to say, *Spizella pallida* is not known from any station in this latitude so far west.

Spizella atrogularis (Cabanis)

Black-chinned Sparrow

California side opposite The Needles, in a ravine among the hills, March 3, male taken (no. 13200); the only one of the species seen on our whole trip.

Junco oreganus thurberi Anthony

Sierra Junco

In willow bottom, on California side at base of Riverside Mountain March 17, female taken (no. 13135); the only junco of any sort seen by us anywhere in the region.

There is a well-preserved skin in the Museum (no. 4143) taken by J. G. Cooper at Fort Mohave, December 24, 1860, and as stated by Cooper (1870, p. 200) a few probably winter regularly in the Colorado Valley.

Amphispiza bilineata deserticola Ridgway

Desert Sparrow

This is a bird of the upland deserts; not one was seen in the riparian belt. Around the base of Riverside Mountain, March 21, several were noted. On the desert back of Ehrenberg, Arizona, March 27, a few were seen; on the California side, opposite Cibola, April 3, a pair was located in a ravine, where they appeared to have established a nesting site; and on the Arizona side ten miles south of Cibola, April 9, two birds were noted in full song. Three skins were obtained, nos. 13324–13326.

There are also in the Museum two skins (nos. 4135, 4136) taken by J. G. Cooper at Fort Mohave, March 18 and April 4, 1861.

Amphispiza nevadensis nevadensis (Ridgway)

Nevada Sage Sparrow

Common early in the season on the desert, especially in the salt-bush and sandy creosote associations. On the California side five miles south of Needles, and on the Arizona side above Mellen, February 20 to 28, many were observed. Their habit of skulking along the ground among the close-set bushes doubtless often resulted in their eluding observation.

Although intermediate sparrows occupied the same sort of ground and were present in much larger numbers, the two species kept in separate companies. The sage sparrows were prone to space themselves out much farther apart than *Zonotrichia*, and flushed singly rather than nearly simultaneously.

Many sage sparrows were observed on both sides of the river at The Needles, March 1 to 5. Nine specimens preserved, nos. 13227–13235.

There is also in the Museum a skin (no. 4137) taken by J. G. Cooper at Fort Mohave, January 26, 1861. That the species winters in the region is therefore practically established.

Melospiza melodia fallax (Baird)

Rocky Mountain Song Sparrow

Common as a winter visitant to the riparian associations. Five miles below Needles on the California side, on both sides of the river at The Needles, on the Arizona side above Bill Williams River, and

at Riverside Mountain, on the California side, the presence of this song sparrow was established by the taking of specimens. The last capture for the season was made at the last-named station, March 17. The ten specimens secured (nos. 13236–13245) are quite uniform in characters and are so exactly like birds from northern Nevada as to leave no doubt as to the source of those individuals of *fallax* visiting the Colorado Valley in winter.

Song sparrows were very often heard when it proved impossible to rout them out from the dense arrowweed thickets in which they took refuge. It thus happened that the identity of most of the song sparrow population known to occur in a locality could not be ascertained. Judging from specimens shot, up to the middle of March, there were about as many *fallax* as *saltonis*. After this time *fallax* had departed from the region for its summer home, and the resident form, *saltonis*, was the only song sparrow remaining. No difference in habits or notes was detected between the two forms, and they appeared to possess identical preferences in regard to feeding grounds and cover. Both often ventured a few yards into open grassy or weedy places occasionally found adjoining the quail-brush belt; and both forms occurred through the willows to the water's edge, where, especially at early morning or late evening, they foraged among drift or through root tangles.

The name *montana* of Henshaw (1884, p. 224) is here considered synonymous with the older *fallax*, of Baird (1854). The latter has been shown to be incorrectly employed for the "desert" song sparrow *resident* along the Gila and Colorado rivers (see Grinnell, 1909, p. 269), and I now fail to see good grounds for recognizing *two* song sparrows from the Rocky Mountain region.

Melospiza melodia saltonis Grinnell

Salton Sink Song Sparrow

This was the form of song sparrow resident along the Colorado River. Song sparrows were noted in the vicinity of every one of our collecting stations from Needles and Mellen to Pilot Knob. Through the big valleys, as we floated along near shore especially in April and May, we were often almost continuously within hearing of them. The presence of *fallax* early in the season renders somewhat uncertain the occurrence of *saltonis* at the two points (Needles and Mellen) where

no specimens of it were actually secured. But elsewhere abundant material testifies to its status.

The occurrence of this sparrow appeared to be correlated closely with the extent of the arrowweed association, or of the almost as attractive young willow growth. The lower ends of the large valleys thus appeared to offer the best conditions. A series of lagoons below Ehrenberg margined with tules and surrounded by arrowweed was notable for its song sparrow population, as was also the "drowned-out" area just above the Laguna dam. Below Potholes, in a growth of mixed cane and young willow, song sparrows were notably numerous; also wherever there was a pure growth of cane, as along "Canebrake Cañon" and on the California bank near Pilot Knob.

All the above areas are yearly subjected to overflow, and this may be held to account for the fact that even up to May 15 not a single new nest or young bird of this species was found. In the vicinity of Salton Sink young have been taken as early as March 30, and are common by the middle of April. It would appear that the birds have in the former region habitually come to defer their nesting time until after the high-water period, the last of May and early June. It was further observed that most of the old nests (which were considered with fair certainty to have belonged to song sparrows) were in arrowweeds or willows above the highest mud mark. The coating of mud on vegetation up to a regular height was indicative of the previous summer's flood level. So that, again, the song sparrows have here accommodated themselves to the extraordinary conditions by building their nests much higher above the ground than is usual elsewhere.

The fifty-one specimens (nos. 13246–13296) of *Melospiza melodia saltonis* obtained by our party, together with three other skins (nos. 4178–4180) taken by J. G. Cooper at Fort Mohave in January, 1861, are in no perceptible degree different from the topotype series from Salton Sink. (See Grinnell, 1909, p. 268.) The larger series now available increases the range of variation in all characters, but not so much that any single specimen, even when considered by itself, would raise a question as to its identity. The Colorado Valley birds, as far as I am able to judge, are not in the least divergent towards *fallax*, it being understood that the latter name applies to the Rocky Mountain song sparrow. It would appear that *saltonis* is very sharply defined both geographically and specifically. It is of further note that Cooper's specimens, taken fifty years ago, are identical with the average *saltonis* as it is today.

Melospiza lincolni lincolni (Audubon)

Lincoln Sparrow

First observed February 26 at Mellen; this is not indicative, however, that the species had not been present all winter in suitable places. Indeed, it seems quite probable that at least a portion of those individuals encountered later had wintered in the Colorado Valley. Very common the first week in March on both sides of the river in the vicinity of The Needles; also in lower Chemehuevis Valley and above Bill Williams River up to March 15; then, in reduced numbers, at Riverside Mountain and Ehrenberg, at the latter point up to March 29. Finally one was taken opposite Cibola April 5, and the last for the season April 7, ten miles below Cibola. At all these points the Lincoln sparrows were confined to the riparian belt, where they affected brush and nearby grass patches, especially at the outer margin of the arrowweed association. They were usually found in close company with song sparrows, though not in the least gregarious; in fact, many were shot by mistake as flushed singly from low herbage, during our pursuit of song sparrows.

Among the twenty-seven specimens (nos. 13297–13323) constituting the series of Lincoln sparrows preserved, much variation is displayed. Most of the specimens are quite typical of *Melospiza lincolni lincolni* as breeding in the Sierra Nevada and Rocky Mountains; but several (six in particular, nos. 13301, 13304, 13311, 13313, 13320, 13322) vary strongly in the direction of *Melospiza lincolni gracilis* (=*M. l. striata* of the A. O. U. *Check-List*, 1910, p. 276). The peculiarities of these lie in the slightly smaller bill, shorter wing and broader black streaking, especially on the dorsum. None, however, are quite like extreme *gracilis*, and this fact, together with the presence in the series of various intermediates, would seem to indicate that the Colorado specimens did not any of them hail from breeding stations in the coast belt proper (Sitkan district) but perhaps from an interlying area towards the interior. This is the more probable, too, in consideration of the fact that in no case was any strictly humid coast belt subspecies found wintering in the Colorado Valley. Possibly the Lincoln sparrows breeding in the northern Rocky Mountain region are subject to greater variation especially towards darkening, and so the dark (and incidentally smaller) Colorado Valley examples may not be essentially *gracilis*. Material is lacking to demonstrate their status satisfactorily.

Pipilo maculatus curtatus Grinnell

Nevada Towhee

Occurred in the river bottom only, and even there not in large numbers. One was seen on the California side near Needles, February 17, and another was taken on the same side five miles below Needles, February 20. One was secured and others heard on the California side of the river in the lower Chemehuevis Valley, March 9. One was heard on the Arizona side at Parker, March 15. And individuals were heard, and one finally secured, March 17, on the California side near Riverside Mountain. In nearly all cases the birds kept close to the arrowweed and quail-brush associations, from within which it was difficult to see them or drive them out, though they were readily heard.

As none was seen after March 29, when two were routed out of an arrowweed thicket near Ehrenberg, this bird is doubtless to be considered only a winter visitant to the region. Careful examination of the three specimens obtained (nos. 13337–13339) showed them to be unlike the *P. m. montanus* resident in the mountains to the eastward in Arizona, and yet quite different from the *P. m. megalonyx* resident in the southern Sierran and San Diegan districts of California. Casting about for comparable specimens disclosed the fact that Colorado River birds were practically identical with examples representing a previously unnamed form, inhabiting in summer portions of the Great Basin region at least of northern Nevada, eastern Oregon and northeastern California. The Colorado Valley birds were thus evidently winter visitants from this region and not from any nearer locality, as far as known (see Grinnell, 1911, p. 309).

Pipilo aberti Baird

Abert Towhee

Abundant resident of the riparian strip along both sides of the river with scarcely a break the whole way from Needles to the Mexican line. Of the four recognized riparian associations—willow, arrowweed, quail-brush and mesquite—the latter two were the ones for which preference was most often shown. Although foraging a few yards outwardly from the mesquite belt, in no instance were these birds found to have followed up the desert washes away from the

river, although the lines of catclaw or palo verde would seem to offer congenial cover. The Abert towhee seems to be closely bound to the vicinity of water, in spite of its evident adaptation in color and structure to a region of desert conditions.

Although we were camped almost continually within the riparian strip, we saw no evidences of the nesting of this species until April 27, on which date near Potholes a half-grown juvenal was found. This, however, appeared to be exceptional, as many adults in pairs were to be seen. A juvenal was taken near Pilot Knob, May 14, where, again, there were no further evidences of nesting. In 1908, Museum collectors found the Abert towhee around the northwest end of Salton Sea, where nests were found plentifully in April; and in the same locality in 1911, Van Rossem (1911, p. 136) found eggs March 20 and 21. It would appear that the Abert towhee, as in the case of the song sparrow, has along the Colorado River deferred its regular time of nesting until relatively late in the season, so as to avoid the period of rising floods.

A series of forty-six specimens (nos. 13340–13385) obtained by the present expedition shows striking uniformity in external characters; that is, individual variation both in respect to color and size lies within very narrow limits. Taking a single feature: twenty-two adult males show a wing length of 89.9 to 95.1 millimeters. The average is 92.3, the mid-point of the range is 92.5, and the variation each side of the mid-point is but 2.8 per cent. In twenty-one adult females the average wing length is 86.8 millimeters; the extremes are 83.0 and 89.4, the mid-point of the range is 86.2, and the variation on either side of the mid-point is 3.7 per cent.

Three specimens are in the Museum (nos. 4115–4117) taken by J. G. Cooper at Fort Mohave, February 19 and April 4 and 24, 1861.

Oreospiza chlorura (Audubon)

Green-tailed Towhee

First seen March 14, on the Arizona side above Bill Williams River, one or two individuals; next April 7, on the same side ten miles below Cibola, two seen; then April 15, on the California side twenty miles north of Pieacho, several; two were seen April 26 on the Arizona side, five miles north of Laguna; and one, on the California side, May 4, five miles northeast of Yuma, and May 8 and 10, one

each day, near Pilot Knob. In all these cases the birds were in the riparian tract, in willows, arrowweed or quail-brush. Although not numerous, the species is clearly a well-established transient through the region.

Five specimens secured, nos. 13332–13336, April 7 to 24, show no sign of even a partial prenuptial molt; if such is actually lacking, the species in this respect resembles *Pipilo* rather than *Zonotrichia*, again showing the affinities of *Orcospiza* to be nearer to the former genus than to the latter.

Two specimens are in the Museum (nos. 4123, 4124) collected by J. G. Cooper at Fort Mohave, February 13 and March 11, 1861.

Zamelodia melanocephala melanocephala (Swainson)

Black-headed Grosbeak

First observed April 12 on the California side twenty miles north of Picacho, one male; next April 25, eight miles east of Picacho, two males; then April 25, five miles north of Laguna, two males. May 4, on the California side five miles northeast of Yuma, many were observed, apparently as a result of arrested migration; for the previous afternoon and all night, as well as on the day of observation, a strong west wind, laden with dust, was blowing across the desert. The black-headed grosbeaks in company with several other transient species were restlessly foraging through the sheltering willow timber of the river bottom. During the succeeding week, practically until we left the region, the species was numerous. On May 13, especially, another windy day, around the east and north bases of Pilot Knob many black-headed grosbeaks were observed towards evening roving out over the desert in companies, as if preparing for through flight.

The above observations, in addition to the fact that dissection of specimens taken showed no signs of immediate breeding, leads to the conclusion that the species occurs in the region only as a transient. A peculiar thing was the late arrival here, as compared with that on the Pacific slope of southern California; in fact, the greater part of the migration appeared to take place here in early May, while the black-headed grosbeaks of the other region had arrived a full month previously and in the majority of cases already had nests and eggs. It would appear likely that the grosbeaks passing through the Colorado Valley are not bound for the Pacific Coast region, but rather to

the Great Basin and northern Rocky Mountain region, where the spring of the Transition zone dawns much later in the season, forcing a much later nesting season.

This idea is further borne out by a comparison of specimens. Breeding birds from the Pacific Coast, selected as being fully adult, are smaller throughout, with particularly less tumid bill than the Colorado Valley birds of obvious maturity. The latter, however, in these particulars, as well as in certain points of coloration, as extent of black on head and extra amount of white on wings and tail, are almost exact counterparts of breeding birds in the Museum collection from the Pine Forest Mountains of northern Nevada. The May birds of the Colorado Valley were thus evidently bound for the elevated interior to the northward. The differences above referred to, as exhibited between Pacific Coast black-headed grosbeaks and those of the Rocky Mountain plateau, would appear to warrant recognition in nomenclature, if for no other reason than to serve in designating their separate course of migration. Ridgway (1901, p. 619) presents data showing the differences in size and proportions, and also (*l. c.*, p. 617) refers to one of the color differences. But he does not consider the races so distinguished worthy of naming. His synonymy (*l. c.*, p. 620) would appear to show that the Rocky Mountain race should probably be called *Zamelodia melanocephala melanocephala* (Swainson) while the Pacific Coast race should bear the name *Zamelodia melanocephala capitalis* (Baird).

Eleven examples of the black-headed grosbeak were secured on the Colorado expedition, nos. 13433–13443. Among these is an aberrancy: No. 13439 is a male of otherwise full plumage, except for the tail, in which there is one old full-length, sticky and bedraggled feather, and ten short feathers, newly unsheathing; this unusual condition at this season was probably induced by loss of tail-feathers through some accident.

Guiraca caerulea lazula (Lesson)

Arizona Blue Grosbeak

First seen May 1, four miles below Potholes, two males; the next day one male. Common at our station on the California side five miles northeast of Yuma, May 3 and 4, as also on both sides of the river in the vicinity of Pilot Knob. Observed here up to the time of our departure, May 15. There was reason to believe that this Lower

Sonoran species was preparing to breed in the river bottom: none were seen outside of the willow and arrowweed associations, and here, especially in clumpy tracts of willow, the males were present and in full song, spaced out over the appropriate territory as if settled for the nesting season. Females were doubtless present also, but only one was seen, probably because of their extremely retiring mood during the season of courtship.

The eight specimens secured (nos. 13444–13451) all on the California side of the river at the three stations above named, together with one more (no. 4132) taken by J. G. Cooper at Fort Mohave, May 6, 1861, are all of the large-billed race inhabiting southern Arizona. They differ markedly from the race summering in central and southern California west of the Sierran divide, in much larger and more tumid bill. (See Grinnell, 1911, p. 163).

Passerina amoena (Say)

Lazuli Bunting

First seen, one of each sex, April 11, twenty miles above Picacho; next, a few examples April 24 and 25, five miles above Laguna; then April 29 at Potholes, and almost daily thereafter at all points to the vicinity of Pilot Knob where last seen May 8. In all cases the birds were observed in the riparian bottom, usually in willows close to the river. There was no evidence of breeding, and the probabilities are that the lazuli bunting occurs in the region merely as a transient. Four examples were preserved, nos. 13390–13393.

There is a specimen in the Museum (no. 4157) taken May 20, 1861, by J. G. Cooper at Fort Mohave. Two of the five specimens have larger bills than any breeding bird at hand from the Pacific slope of California. This might be interpreted as being a parallel to the case with the black-headed grosbeaks, the Colorado River buntings being migratory to the Great Basin region. The material at hand, however, is insufficient to elevate the supposition to even a probability. And apparently there is, besides, a wide range of variation of the characters in question.

Calamospiza melanocorys Stejneger

Lark Bunting

On March 8, on the California side opposite The Needles, a flock of a dozen lark buntings alighted in the tops of some tall willows close

to the river. Four were shot, nos. 13327–13330, all proving to be males in winter plumage. In these the lower parts are irregularly blotched with black. Two more were seen the same day in a willow on the California side a few miles below, in Blankinship Valley. A solitary female (no. 13331) was secured ten miles below Cibola, on the Arizona side, April 8. This bird was perched upon the wall of an adobe ruin on a spur of the mesa abutting upon the river.

Piranga ludoviciana (Wilson)

Western Tanager

Common as a migrant. First seen, a male, on the Arizona side five miles above Laguna, April 25; another male noted there the next day. Several were seen at Potholes, April 29, and four miles south of Potholes, May 1.

Five miles northeast of Yuma, on the California side, May 4, a very conspicuous arrested migration was in evidence among many species of transient birds. A heavy westerly wind blew all day, and the thick willow and cottonwood growth close to the river furnished both shelter and forage. Western tanagers were present in large numbers. I counted twenty in sight at one moment, flying serially along the edge of the woods. In the vicinity of Pilot Knob, up to May 15, this species was numerous, both on the bottom lands, and out on the desert. On the 7th and 13th, many western tanagers, singly and in pairs, were seen flying to the northwest low over the desert mesa north of Pilot Knob, frequently alighting for a moment in creosote bushes or ocotillos before resuming their transit. Eight specimens of this tanager were obtained, nos. 13415–13422.

Piranga rubra cooperi Ridgway

Cooper Tanager

First seen April 20 on the California side of the river eight miles east of Picacho: a single full-plumaged male which was secured. It attracted attention through its typical tanager call note, "pritit"; but the bird was difficult to discern in spite of its brilliant red attire, amid the vivid green of the new foliage of the willow thicket in which it ensconced itself.

The species was next observed April 30 and May 1 in the bottom lands four miles below Potholes (in California), and then, on the same side of the river, five miles northeast of Yuma, May 3 and 4. At each of these places a dozen or more individuals were seen. On both sides of the river in the vicinity of Pilot Knob, May 5 to 15, this tanager was frequently observed. While the call note was closely similar to that of the western tanager, present as a migrant in numbers at the same time, the song was quite different, being a clear, full-toned warble more nearly like that of the black-headed grosbeak, yet with an individuality of its own.

The Cooper tanager, as far as our observations went, is strictly confined to the willow association. Not one bird was seen even so far from this association as the mesquite belt. The species is evidently a regular summer visitant.

The ten specimens secured, nos. 13423–13432, are all males. One of these was thought to be a female until dissected, as it is in a greenish-yellow phase of coloration. However, there are scattering pale reddish feathers in nearly every feather tract, though there is no indication that any molt is in actual progress. This is probably a case of arrested molt.

The notable absence of female specimens in our series resulted in spite of our greater effort to secure that sex. It was not that the males were more conspicuous, though this may have been a factor against that sex, but that the females were at this season extremely wary. As a pair was approached the female was always first to take alarm. I was repeatedly able to distinguish females at a distance as soon as males, in some cases sooner, after having located the pair by their notes. The red of the male appeared to be neutralized by the shimmering green of the surrounding foliage, so that the male was no more quickly discerned than the female. The male, however, was far more conspicuous in flight across open spaces.

There are in the Museum two skins (nos. 4202, 4203) taken by J. G. Cooper at Fort Mohave, April 29, 1861.

Petrochelidon lunifrons lunifrons (Say)

Cliff Swallow

This swallow is evidently a common breeding species along the Colorado River wherever appropriate nesting sites are afforded. But we found the birds remarkably late in arriving and in nest-building.

Many cliffs, from the vicinity of The Needles on down the river, were seen with remains of nests adhering to their faces in rows or patches. The first birds noted were a very few flying high overhead near Riverside Mountain, March 17. Next seen near Ehrenberg, March 26. Several were seen April 12 coursing over the river and bottom lands twenty miles north of Picacho. Not noted again until May 5, when at Yuma a large colony was seen constructing nests on the steep rocks on the Arizona side near the prison. The birds were gathering mud at the edge of the river on the California side, thronging back and forth over the unusually narrow channel at this point.

On the California side in the vicinity of Pilot Knob two large nesting colonies were in evidence. One was on a sandstone bluff of some twenty-five feet height past which the main current of the river swung with exceptional speed. Here the nests were attached, to the number of ninety-seven, mostly as yet incomplete, to the irregularly eroded surface of the rock from ten to twenty feet above the surface of the river at its present stage—evidently above the reach of the highest level at flood time. Four of the finished nests were investigated on May 9 and found to contain in two cases three fresh eggs, in two cases one fresh egg.

On the same day, sixteen of the birds were shot for specimens. The skiff was repeatedly rowed out from shore a little below the colony, and as it was swept down stream by the current was pulled back again by means of a long rope manipulated by a man on shore. Those swallows flying nearest the boat upstream in front of the colony were shot at, so that the dead birds would float past within reach. Of the sixteen secured, fifteen were males. There is no way that I know of to determine sex until the birds are in hand. This would seem to indicate that the females at this time in the breeding season are most retiring, and that the males are the ones to make demonstrations of alarm when the colony is invaded by an enemy.

The other colony located had taken possession of the concrete walls in the head-gates of the Imperial Canal at Andrade. The nests were being constructed in crowded rows in the lateral upper corners beneath the woodwork bridging the piers. The birds were gathering mud at the margin of the canal nearby, alight with uplifted wings. Four shot were all males.

The superintendent of the canal, stationed at Andrade, complained that the swallows proved a nuisance by dirtying up the painted wood-

work. He had tried to drive them away repeatedly in previous years by destroying their nests. But the birds persisted in returning. Last year he had procured a quantity of poisoned wheat and spread it out on nearby ground, without, however, bringing any perceptible results!

Our nineteen specimens, nos. 13396–13414, show slight peculiarities as compared with examples from central California and Illinois. They are smaller: wing 100.0 to 108.0, averaging 103.2 mm. (see Ridgway, 1904, p. 48); the frontal light patch is cinnamon instead of whitish; the feathers of the dorsum are more conspicuously edged with clear white; the belly is whiter. These differences are indicative of the probable fact that the cliff swallows of the lower Colorado Valley are near in derivation to the forms in Mexico, particularly *Petrochelidon lunifrons tachina* Oberholser, which is recorded north on the east side of the Mexican plateau to southern Texas.

Hirundo erythrogastra Boddaert

Barn Swallow

Observed but once: one, evidently a migrant, flying overhead at Potholes, April 29.

Iridoprocne bicolor (Vieillot)

Tree Swallow

Recognized but once: March 23 a small number were noted flying back and forth over the second bottom on the California side at our collecting station above Blythe. One specimen taken, no. 13394. Evidently only a transient through the region.

Tachycineta thalassina lepida Mearns

Northern Violet-green Swallow

First noted March 4 opposite The Needles. No birds were actually seen; but a tumult of the characteristic twitterings high overhead belonged unmistakably to this swallow. The sky was dazzlingly bright so that small objects at but a moderate distance were invisible. Next seen with certainty, ten or so, on the Arizona side, March 7; then above Bill Williams, March 13. A few violet-green swallows were seen above Blythe March 23, in company with other swallows; simi-

larly at Ehrenberg, March 26 and 28; two seen opposite Cibola, April 5; and a few ten miles south of Cibola, April 8. One specimen taken, no. 13395. The species occurs in the region as a transient only.

Stelgidopteryx serripennis (Audubon)

Rough-winged Swallow

First noted February 20, three individuals, five miles below Needles on the California side; next noted at Mellen, Arizona, February 23, thenceforth observed daily and at every station all the way down the river to Pilot Knob. This swallow forages alike over the river and flood-plain, and out over the desert where I saw it as far as I went (opposite Cibola fully six miles from the river). At Ehrenberg, March 24 to 29, many rough-winged swallows were to be seen close about the old adobe houses. They roosted by the half-dozen on wires stretched overhead for drying meat. Rafter holes in the walls, up under the thatches of those houses still possessing roofs, would appear to offer attractive nesting sites for these swallows. Individuals were seen flying up to such openings, though actual nest-building had not yet commenced.

Back in the hills, two to five miles west of the river and twenty miles north of Picacho, one or two pairs were noted in nearly every ravine. April 16 a nesting site was located in a naturally eroded hole in the face of a conglomerate wall. The cavity was too deep and too small to investigate. But the actions of the birds plainly indicated that it held either eggs or young.

At a number of places below Picacho, and down to Pilot Knob, nesting holes of rough-winged swallows were observed in banks, but always above flood level. In no case did we see birds attempting to nest in banks subject to undercutting or overflow, although these would appear to be in some cases otherwise quite suitable, suggesting extraordinary powers of anticipatory "discrimination" on the part of the birds. Near Pilot Knob, May 14, a nest burrow was found in the wall of a wash meeting the river at right angles, and only some fifty feet from the brink of the main bank. This burrow was about eight feet above the floor of the wash; the terminal cavity was found to contain one fresh egg. Twenty-six specimens of this swallow were secured, nos. 13452–13477.

Bombycilla garrula (Linnaeus)

Bohemian Waxwing

Known from the region only from the female specimen, now no. 4207 in this Museum, taken by J. G. Cooper at Fort Mohave, January 10, 1861.

Phainopepla nitens (Swainson)

Phainopepla

Everything indicated that this bird was common as a permanent resident of the region. It was, however, closely restricted to two narrow belts paralleling the river, one on each side; namely as constituting the mesquite association. The close coincidence of the range of the bird with the plant association in question was here clearly due solely to the preferred food afforded in constant and abundant quantity by the berries of the mistletoe parasitic upon the mesquite. Judging from experience elsewhere, there is reason to believe that the phainopepla would have availed itself of edible berries in whatever part of the region these might have been produced. Yet the fact remained that in the Colorado Valley the bird's presence and distribution was remarkably controlled by those of the mesquite; where there were no mesquites, as at our station near Pilot Knob, not a phainopepla was seen; where the mesquite had amassed itself into an extensive belt, the birds abounded.

In certain places, as on the Arizona side above Mellen, and on the California side opposite Cibola, this bird was, within the riparian strip, the most abundant single species. In such localities the birds overflowed in small numbers a little way up contiguous desert washes, foraging about palo verdes or ironwoods, which latter plant occasionally bore mistletoe clumps.

The phainopepla nested earlier than most of the resident birds of the region. Bob-tailed young out of the nest were seen April 12 on the California side, twenty miles above Picacho. April 5, on the same side opposite Cibola, two nests were found, each containing two eggs nearly hatched. In one of these cases the nest was eight feet above the ground on a branch of an ironwood; in the other, sixty-two inches above the ground on a mesquite limb. A nest with three fresh eggs found April 11 at the first-named locality, was seven feet above the

ground in a mesquite. These situations are representative of the average predilections of the species in other regions.

Thirty-two specimens of the phainopepla were preserved, nos. 13478–13509. There are in the Museum five specimens (nos. 4196–4200) taken by J. G. Cooper at Fort Mohave, December 24, 1860, and January 17 to April 13, 1861.

Lanius ludovicianus excubitorides Swainson

White-rumped Shrike

Shrikes proved unexpectedly scarce in the region explored. In spite of our special exertions, only four specimens were secured, nos. 13386–13389. Besides these, there are two more in the Museum (nos. 4205, 4206) taken at Fort Mohave by J. G. Cooper, April 18, 1861, and December 26, 1860. The six specimens show much variation among themselves, and not enough of uniformity in any one character to suffice for recognition, as I had anticipated, of a Lower Sonoran form of the *excubitorides* type different from an Upper Sonoran or Transition one. It is quite possible that some of the variation exhibited, as in degree of paleness and size and outline of bill, may be due to the fact that in the series some individuals were resident birds and others winter visitants from the Great Basin region. At any rate, the small series is inadequate as a basis for any satisfactory study of subspecific status. I am therefore including all under the name *excubitorides*, with the suggestion that it will probably be found after more extensive collections are worked over that further subspecific separation will have to be made.

Our first specimen was taken February 15 at Needles, and like several other birds of that neighborhood, the plumage was seriously discolored by coal smoke. Another was taken five miles below Needles, February 22, and one additional pair seen there. A pair was seen on the Arizona side near Mellen, February 24 and 27. Next noted at Ehrenberg, where a lone individual was secured March 28; next on the same side five miles above Laguna, where one was taken April 24. Last seen May 15 near Hanlon Junction, just north of Pilot Knob. In all these cases, the shrikes were in desert washes from a half-mile to two miles from the margin of the riparian belt. As usual they chose the most open ground productive of an adequate food-supply.

Vireosylva gilva swainsoni (Baird)

Western Warbling Vireo

First noted April 1, opposite Cibola. Thenceforth of almost daily observation at all our stations from there to Pilot Knob, where still common May 14. At times numerous in the willows; a few noted in the mesquite belt. Evidently a plentiful migrant through the region. Fourteen specimens taken, nos. 13537–13550.

Lanivireo solitarius cassini (Xantus)

Cassin Vireo

Occurred only in April and as a transient. First seen on the 7th of that month on the Arizona side ten miles below Cibola. One was found on the 9th singing volubly from an ironwood in a desert wash; all the rest seen were in the willow belt. On the California side, twenty miles above Picacho, several were noted April 10 and 11. Thereafter none were seen anywhere. Four specimens, nos. 13533–13536.

There is also in the Museum a skin (no. 4247) taken by J. G. Cooper at Fort Mohave, May 14, 1861.

Vireo belli arizonae Ridgway

Arizona Least Vireo

First detected early in the morning of March 8, on the California shore opposite The Needles. Heard repeatedly the same day from both banks as we floated down to lower Chemehuevis Valley. Nests, a year or more old, were seen both in the vicinity of The Needles and above, and the inference was that the species arrived throughout the region in full force on the above date. Thenceforth the species was met with at all stations all the way down the river, being one of the most characteristic avifaunal elements in the riparian strip. The bird foraged in all of the component associations, but was perhaps best represented in the willow association, especially where there was an undergrowth of guatemote (*Baccharis glutinosa*).

On the Arizona side above Bill Williams River, March 14, I was able to make some observations on local distribution. Here the willow association was narrow but well defined, and the vireos were closely confined to it. A singing male occupied each segment of about 200 yards in this belt, just about the same spacing as the Lucy warbler

in the adjacent mesquite belt. Each pair of vireos was closely delimited in its forage beat by that of its neighbor. Each pair in its own area actively resented encroachment by others of its own species. The vireos worked a rather low zone of foliage, from the ground up to a height of six or eight feet, just about the same, again, as in the case of the Luey warbler. It is of interest to note that the Sonora yellow warblers, which arrived much later, after the willows had leaved out, were spaced much closer, but foraged through a greater *depth* of verdure, from the summits of the willows to within five or six feet of the ground. The vireo's domain was but slightly impinged upon.

At Ehrenberg, Arizona, a newly started nest was found, March 29. It was at this date about half completed, and was attached to the forking stalk of a guatemote five feet above the ground. It would appear that many nests meet with disaster from their being built, as they so often are, in openings between thickets. These openings serve as passage ways for browsing cattle, which as they crowd through, force the supporting branches aside and demolish the nests. Evidence of a number of instances of this type of catastrophe came to notice. A partly completed nest found on the California side near Pilot Knob, May 12, the owners being seen in the vicinity, would, together with the previous instance, indicate a length of breeding season of at least six weeks. Repeated trials, following such common accidents as the above, may account for this.

A nest found April 24 on the Arizona side, five miles above Laguna, was located three and one-half feet above the ground on a horizontal willow branch, beneath and darkly shaded by several small willow trees growing close together at the margin of an overflow slough. The nest preserved (no. 759), is of normal construction for vireos of this genus. The chief constituents are weathered mesquite and willow bark strips and spiderweb and cocoons; the inner lining is of fine round grass stems and shreds of dry grass blades. The eggs, four in number, were advanced about one-third in the process of incubation. The egg-shells are pure white, dotted very sparsely about the large ends with bay and hazel.

The series of twenty-three adult specimens taken (nos. 13510–13532) establishes clearly the identity of the Colorado Valley birds with *Vireo belli arizonae* of south central Arizona. The range of this geographic race is thus carried over into the confines of California along the southeastern frontier of the state.

Vermivora luciae (Cooper)

Lucy Warbler

First seen March 10, on the California side in lower Chemehuevis Valley; there were three individuals foraging quietly in company with Audubon warblers and ruby-crowned kinglets in the sunlit summits of willows. The one shot was a male. The Lucy warbler is undoubtedly absent from the region in winter, and the above observation indicates approximately the date of its arrival.

Next noted March 14 on the Arizona side above Bill Williams River. Here, at least four males were located in mesquites, and as they were in full song and spaced apart, had doubtless settled upon breeding locations. The song is unmistakable, as far as all other birds of southern California and Arizona are concerned. It resembles the song of the Sonora yellow warbler in length and frequency of utterance and somewhat in quality, but with a distinct hurried and lisping effect reminding one of the song of the Lazuli bunting.

On the California side, both at Riverside Mountain and above Blythe, Lucy warblers were numerous, and very closely confined to the narrow belt of mesquite. The singing males, each representing the forage area and nesting site of a pair, were spaced out very uniformly, so that an estimated strip of about 200 yards in length belonged to each. The birds foraged out to a limited extent from the mesquites towards the river into the arrowweed and willows, and away from the river at the mouths of washes into the ironwoods and palo verdes. But the metropolis was always most emphatically the mesquites. At this time, March 18 to 23, the mesquites were just coming into leaf, and the new yellow-green foliage was prolific of insect life and formed both a productive food-source and an excellent cover for a low-foliage feeder, such as the Lucy warbler pre-eminently is.

At Ehrenberg, Arizona, the last week of March, the species was common, as also on the California side opposite Cibola the first week of April, and on the Arizona side, again, ten miles below Cibola. At the latter point a nest, nearly completed, was found April 8. It rested upon a loosened skein of bark on the under side of a slanting mesquite trunk, and was five feet above the ground.

On the California side the Lucy warbler was fairly common in the vicinity of our stations twenty miles above and eight miles east of Picacho, at both points being closely adherent to the mesquite strip.

Not one was observed anywhere below the last-named station, and this fact we ascribed to the lack of mesquite at the remainder of the points visited, this wood having been cut out for fuel.

It was a particularly gratifying circumstance that a nest of the Lucy warbler was found by us on California territory, thus adding a species to the state list of breeding birds. As above implied, individuals were encountered in fair numbers at our station twenty miles above Picacho. Here, as usual, they affected the mesquite belt, but strangely enough the nest found was situated in a nearly dead ironwood, at the base of a hill rising abruptly from the river bottom. This tree (see pl. 12, fig. 19) evidently owed its failing condition to the rising water level in the ground in which it grew, a circumstance as fatal to an ironwood, as it is, up to a certain degree, propitious to a mesquite. There were young mesquites in the immediate vicinity.

The nest was built thirty-five inches above the ground in the crotch where a steeply inclined branch sprang from the main trunk, which was here about one foot in diameter. The nest was sheltered from above by a two-inch strip of loosened bark and an outstanding twig. The nest was thus practically within a closed cavity save for an approach in one direction, as shown in the photograph (pl. 13, fig. 20). This falls within the known predilection of the species elsewhere, as in the upper Gila Valley of south central Arizona (Gilman, 1909, p. 168), where out of "twenty-three nests observed, twelve were in natural cavities, four under loose bark, four in woodpecker holes, and three in verdin's nests."

The nest in question was evidently a relining of a previous year's structure, the latter being distinguishable by its compactness and admixture of dried mud, as if it had been sifted full of wind-blown dust and then drenched by heavy rain. There was no evidence that the tree had been submerged to this depth. The new portions of the nest (no. 754) are loosely formed of various feathers (mostly down-feathers of desert quail), mingled with weathered shreds of grass. There is a scanty lining of fine hairs. The cavity of the nest is 45 mm. across, by 22 mm. deep.

The three eggs, taken April 12, were considerably incubated, and thus constituted a full complement. The shells are pure white, with a fine and abundant speckling of vinaceous, vinaceous-cinnamon and cinnamon-rufous, chiefly in an agglomerated ring about the large ends. Some of the markings nearest the pole at the large end are

splotchy rather than punctulate. The eggs are rounded-ovate and measure in millimeters 14.0 by 11.7, 14.6 by 11.8, and 14.0 by 11.6. Only the female parent was observed in the vicinity of the nest and, as noted by Gilman, there was a notable lack of expressed anxiety. The bird merely remained among distant mesquites, uttering an occasional faint, one-syllabled alarm note.

Twenty-five specimens of this warbler were obtained, nos. 13579–13603.

The Lucy warbler was originally discovered at Fort Mohave, which is on the Arizona side of the river. Its describer, J. G. Cooper (1861, p. 120), remarks as follows: "This bird was common at Fort Mojave, near Lat. 35°, in the Colorado Valley, where it arrived about March 25th, and remained until I left there, the twenty-eighth of May. I saw none along the Mojave river, on the route westward. I collected five male specimens and one female."

Two of Cooper's specimens are in the Museum collection: female, no. 4266, April 5, 1861; male, no. 4267, April 11, 1861. These may with propriety be considered co-types, at least. Although no single specimen had been designated as type, Ridgway (1902, p. 474) indicates that a specimen which he considers the type is in the United States National Museum; this is probably one of the five males referred to by Cooper. Both our specimens have the original label, on faded blue note-paper, giving full data, entirely in Cooper's own handwriting. The female has "luciae, n.s. Cooper" in one corner in the same faded ink as on the rest of the label, except that both specimens have "luciae, J. G. C." interlined in blacker ink, just beneath the original "Helminthophaga," evidently inscribed by Cooper at some later time.

Vermivora ruficapilla gutturalis (Ridgway)

Calaveras Warbler

First noted April 7 to 9, on the Arizona side of the river, ten miles below Cibola. Here they were not uncommon in the upper foliage of blossoming willows. Next observed on the opposite side, twenty miles north of Picacho, April 11, with similar mode of occurrence; then five miles above Laguna, April 25, and at Potholes, April 29. Here, and four miles south of Potholes, up to May 2, this was one of the commonest warblers. One was seen five miles northeast of Yuma, May 3; and in the vicinity of Pilot Knob, May 6 to 15, a few were

seen daily. The species was thus well represented as a migrant through the region.

Twelve specimens were taken, nos. 13551–13562. No. 13522, an adult male, shows conspicuously a character not mentioned in text descriptions, namely, a mixture of long, fine, black hairs (filoplumes) in plumage of sides and especially the flanks. Examination of appropriate series of specimens shows this character to be possessed in varying degrees, even in female first-winter plumage, by both *Vermivora ruficapilla gutturalis* and *V. r. ruficapilla*, but not by other members of the genus.

Vermivora celata celata (Say)

Orange-crowned Warbler

Apparently the only member of the genus present in the Colorado Valley through the winter. That it does winter here is quite apparent from its being observed by us almost daily during the latter part of February, and early March, whenever we were at work in favorable localities. Later its identity was obscured by the arrival of its close relative, *Vermivora celata lutescens*, which, as a migrant, outnumbered *V. c. celata*.

The orange-crowned warbler was closely confined to the riparian strip, where it foraged singly at a low level in the tangle of underbrush in the willow association, or, less often, in the arrowweed thickets. Its presence was betrayed as a rule through the sharp, single call note. Though usually repeated at not infrequent intervals, this clue was not always alone sufficient for the discernment of the bird, because of the impenetrability of its cover.

The first bird was seen in the river bottom near Needles, February 17. On the 20th, five miles below Needles, a specimen (no. 13574) was secured. Although observed frequently, no more were obtained until April 8, when one (no. 13575) was taken on the Arizona shore, ten miles below Cibola. On the California side, eight miles east of Picacho, another (no. 13576) was taken April 20. And two examples were secured on the same side near Pilot Knob, May 9 and 14 (nos. 13577, 13578).

These five specimens are unequivocally *celata*, save that one shows a slight but notable aberrancy. This is no. 13577, a male, in which the grayness characteristic of *celata* pervades the plumage as usual,

except facially, where it is replaced on the chin, lores, supereiliary line, lower eyelid and fore part of auriculars with the clear greenish yellow peculiar to *V. c. lutescens*. This abrupt replacement is bilaterally uniform and so conspicuously in evidence as to suggest the style of coloration in the yellow-faced gray-bodied verdin. It is probable that the warbler in question is a hybrid between *V. c. celata* and *V. c. lutescens*, having been bred in a region where the ranges of these two forms meet. Such a locality is Prince William Sound, Alaska (see Grinnell, 1910, p. 409).

Vermivora celata lutescens (Ridgway)

Lutescent Warbler

Common as a migrant, chiefly in April and May. Two specimens taken February 23 and 28 at Mellen, Arizona, may have been wintering in the region; no more were encountered until March 29, at Ehrenberg, when two in full song came to notice; thereafter the species was observed almost daily, though not in numbers. The willow strips formed the main forage-ground. The last specimen was taken May 7, on the California side near Pilot Knob.

The eleven specimens preserved (nos. 13563–13573) are varyingly grayer than breeding birds (May and June) from the Pacific Coast. But it is clear that a slight ashy obscuration in some degree accounts for the duller yellow of the early spring birds. The underlying yellow of the male appears just as intense in February and March examples as in June birds. Wear removes most or all of the ashy feather tips.

Dendroica aestiva sonorana Brewster

Sonora Yellow Warbler

First encountered April 8, a single adult male, on the Arizona side ten miles below Cibola; next noted April 10, two in song on the California side, twenty miles north of Picacho; many on the morning of the 17th near the same place. When we reached our station on the California side eight miles east of Picacho, April 17, Sonora yellow warblers were abundant. As this was a particularly favorable locality, more so than the last, it is fair to infer that the species had arrived in force some days previously. Even so, the first appearance of yellow warblers along the Colorado River was later than the usual date of

arrival of the closely related *Dendroica aestiva brewsteri* at the same latitude in the San Diegan district of southern California; and this in spite of the lower zone of the Colorado Valley.

The Sonora yellow warblers were abundant at all suitable places along down the river from Picacho, the stations being indicated in the accompanying table of measurements. They adhered closely to the willow association, the mode of their forage zone lying somewhere in the crown foliage of the willows and cottonwoods, the height above the ground of course varying with the stature of the trees. The females were hard to locate, but the incessant song of the male birds rendered the latter easy to detect. Observation on April 19 in a very extensive willow tract in "Charlie's Valley," eight miles east of Picacho, showed them to be regularly spaced out through the top foliage at an estimated frequency of four per acre. Thus, at this point, a quarter of an acre, with a depth of perhaps twelve feet of foliage, was the forage allowance of each nesting pair of warblers. This was a greater congestion of warbler population than in most places, because of the evident unusual favorableness of the environs.

At another place, five miles above Yuma, May 3, there was only one singing male to two acres of willows. With a minimum of 640 yellow warblers to the square mile, their aggregate numbers in the Colorado Valley must reach an enormous total, considering the vast area of first bottom. Since there is in the Museum collection a female specimen (no. 4265) of *Dendroica aestiva sonorana* taken by Cooper May 4, 1861, at Fort Mohave, it is reasonable to suppose that this form breeds north in uniform abundance along the valley to the Nevada line. In spite of the numbers of the birds, we failed to run across nests. This may, however, have been due to nesting being deferred until later than the middle of May.

The series obtained of this warbler (forty-seven specimens, nos. 13604–13650) provides so much material of a bird not heretofore adequately represented in our collections, that a rather detailed examination of its characters seems warranted. Furthermore, so many examples of one species of migratory bird from so limited an area, and taken practically within a month's time at one season, would seem to be a basis from which to obtain a fair idea of normal variation.

Referring first to the accompanying table of measurements, it will be noticed in the males that the average and the mid-point of the range practically coincide; that the variation in the six respects varies

from six to nine per cent on either side of the mid-point; that the wing length is most constant; that in average dimensions females are smaller than males *except* that the bills in the former are slightly the larger.

Although little more than three weeks apart in time of capture, the May birds are distinctly more worn than those of April 18. This undoubtedly accounts for the slight lessening in wing length, and also modification in wing formula, as exhibited bottomwards in the appropriate columns. In obtaining the wing formula as given, the primaries are numbered consecutively from the carpal joint distally. The numbers are arranged in order of relative length of the primaries, the first given being the longest; thus 8-7-6-9-5-4-3-2-1 means that the eighth primary is longest, the seventh next in length, and so on. Since in this bird the primaries proximally from number 5 in all individuals decrease in length with regularity, only the variable (outer) portion of the formula is given. The variation in wing formula as shown in the table *appears* to be greater than it really is, for in most cases 6, 7, and 8 are very nearly of a length, 9 being proportionally shorter but in no case as short as 5. Eight and 7 are most frequently of greatest length.

In coloration the females are paler, being more ashy and less yellow than in either *D. aestiva aestiva* or *D. aestiva brewsteri*. The males, on the other hand, have the yellow more intense and extensive, involving the whole head and back, and represented on the wings and tail by much broader edgings. The green mantle of *brewsteri* is represented in *sonorana* by a more restricted area of dull yellow, the whole head and rump being brightly yellow. The yellow of the crown is often tinged strongly with chestnut, and the dorsum is streaked narrowly with a darker tone of the same color. The underparts are even more narrowly chestnut-streaked than in *brewsteri*. Variation in the latter respect is considerable, from a case where the ventral streaking is scarcely perceptible to the opposite extreme, where the streaking is about as well defined as in average *brewsteri*.

Sonorana, as shown by the present series, is an easily recognized form, in spite of its great range in individual variation. For, among so many characters, where one fails, others are left to hold to.

MEASUREMENTS[1] IN MILLIMETERS OF *DENDROICA AESTIVA SONORANA*, FROM THE LOWER COLORADO VALLEY

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Hind toe with claw	Bill from nostril	Gonys	Wing formula[2]
13604	♂	10 mi. S. Cibola, Ariz. side	Apr. 8	64.7	46.6	19.0	11.0	7.8	7.2	8–7–6–9–5
13605	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.3	44.1	18.4	11.0	7.4	7.1	7–8–6–9–5
13606	♂	8 mi. E. Picacho, Calif. side	Apr. 18	62.4	47.0	18.0	11.4	7.7	7.0	8–7–9–6–5
13607	♂	8 mi. E. Picacho, Calif. side	Apr. 18	62.5	48.6	18.8	11.1	8.4	7.7	7–8–6–9 5
13608	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.3	45.0	18.4	10.0	8.0	6.9	.....[3]
13609	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.1	46.4	17.1	10.0	7.3	6.6	7–8–6–9–5
13610	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.5	45.7	18.5	11.3	8.2	7.5	9–8–7–6–5
13611	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.2	44.9	17.3	10.0	7.7	6.7	8–7–6–9–5
13612	♂	8 mi. E. Picacho, Calif. side	Apr. 19	60.9	45.0	17.8	11.2	7.8	6.9	7–8–6–9–5
13613	♂	8 mi. E. Picacho, Calif. side	Apr. 20	61.4	44.5	18.3	10.1	7.5	7.0	8–7–6–9–5
13614	♂	8 mi. E. Picacho, Calif. side	Apr. 20	62.5	45.0	18.8	10.4	7.7	7.0	8–7–6–9–5
13615	♂	8 mi. E. Picacho, Calif. side	Apr. 20	60.5	44.0	17.7	10.0	7.9	7.1	7–8–6–9–5
13616	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.3	45.5	18.9	11.0	8.2	7.5	8–7–6–9–5
13617	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.9	47.1	19.0	10.0	7.8	7.1	7–8–6–9–5
13618	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.6	45.2	18.5	10.4	7.7	7.2	8–7–6–9–5
13619	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.0	44.8	18.0	10.1	8.0	7.2	8–7=9–6–5
13620	♂	5 mi. N. Laguna, Ariz. side	Apr. 26	63.0	45.7	17.8	10.5	7.8	7.0	7–8–6–9–5
13621	♂	5 mi. N. Laguna, Ariz. side	Apr. 24	63.4	46.0	18.4	9.8	7.5	7.0	7–8–6–9–5
13622	♂	5 mi. N. Laguna, Ariz. side	Apr. 25	62.8	47.2	18.9	10.2	7.5	6.8	8–7–6–9–5
13623	♂	5 mi. N. Laguna, Ariz. side	Apr. 26	61.3	44.8	18.0	11.3	7.6	6.7	7–6–8–9–5
13624	♂	4 mi. N. Potholes, Calif. side	Apr. 23	63.5	47.0	17.9	11.0	7.3	....[3]	7–8–9–6–5
13625	♂	Potholes, Calif. side	Apr. 27	64.6	47.1	19.2	11.0	7.8	*7.5	8–7–6–9–5
13626	♂	Potholes, Calif. side	Apr. 27	62.8	47.0	18.8	10.3	7.4	7.0	7–8–6–9–5
13627	♂	Potholes, Calif. side	Apr. 27	62.7	45.0	17.9	10.7	7.6	7.0	8–7–6–9–5
13628	♂	Potholes, Calif. side	Apr. 27	63.7	46.1	18.6	11.0	7.5	7.3	7–8–6–9–5
13629	♂	Potholes, Calif. side	Apr. 28	62.4	44.1	19.0	10.8	7.8	7.3	8–7–6–9–5
13630	♂	Potholes, Calif. side	Apr. 29	58.4	41.7	18.0	10.6	7.3	7.0	8–7–6=9–5

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Hind toe with claw	Bill from nostril	Gonys	Wing formula[2]
13631	♂	4 mi. S. Potholes, Calif. side	Apr. 30	62.2	47.5	17.7	9.7	7.4	7.0	8=7-6-9-5
13633	♂	4 mi. S. Potholes, Calif. side	May 1	63.2	46.0	18.8	11.5	7.7	7.2	7-8-9-6-5
13634	♂	4 mi. S. Potholes, Calif. side	May 2	63.4	46.0	18.0	10.3	7.6	7.0	8-7-6-9-5
13636	♂	4 mi. S. Potholes, Calif. side	Apr. 30	61.3	45.5	17.6	11.0	7.7	7.0	8-7-6-9-5
13638	♂	5 mi. N.E. Yuma, Calif. side	May 3	57.3	40.2	18.4	11.1	7.3	7.0	8-7-9=6-5
13639	♂	Near Pilot Knob, Calif. side	May 6	59.3	43.0	18.5	10.5	7.8	7.1	8-7-6-9-5
13640	♂	Near Pilot Knob, Calif. side	May 6	63.5	45.7	18.0	10.1	7.7	7.6	8-7-6-9-5
13641	♂	Near Pilot Knob, Calif. side	May 6	61.6	45.4	18.7	10.4	8.0	7.6	8-7-6-9-5
13642	♂	Near Pilot Knob, Calif. side	May 8	58.0	41.0	16.8	10.4	7.6	7.0	.....[3]
13643	♂	Near Pilot Knob, Calif. side	May 9	58.0	40.8	18.0	11.3	8.2	7.3	.....[3]
13644	♂	Near Pilot Knob, Calif. side	May 11	59.0	42.0	17.0	9.7	7.4	7.0	7=8=9-6-5
13646	♂	Near Pilot Knob, Calif. side	May 12	60.3	42.3	18.4	11.2	7.4	7.1	8-7=9-6-5
13647	♂	Near Pilot Knob, Calif. side	May 14	58.2	44.5	18.8	10.8	7.8	7.1	8-7-9-6-5
13649	♂	Near Pilot Knob, Calif. side	May 7	57.4	41.4	18.6	10.6	7.9	6.9	8-7-9-6-5
		Average of the 41 ♂♂		61.5	44.9	18.2	10.6	7.7	7.1	
		Maximum		64.7	48.6	19.2	11.5	8.4	7.7	
		Minimum		57.3	40.2	16.8	9.7	7.3	6.6	
		Mid-point of the range		61.0	44.4	18.0	10.6	7.8	7.1	
		Percent variation on either side of mid-point		6.0	9.0	6.6	8.5	7.0	7.7	
13632	♀	4 mi. S. Potholes, Calif. side	May 1	59.3	43.2	18.6	11.3	8.1	7.3	9-8-7-6-5
13635	♀	4 mi. S. Potholes, Calif. side	May 2	60.8	43.6	18.0	11.0	7.9	7.4	7-6-8-9-5
13637	♀	4 mi. S. Potholes, Calif. side	May 1	58.8	43.0	19.3	10.7	....[3]	6.7	8-7-9-6-5
13645	♀	Near Pilot Knob, Calif. side	May 12	55.0	39.6	17.6	10.7	7.6	7.5	9-8-7-6-5
13648	♀	Near Pilot Knob, Calif. side	May 6	60.0	43.0	17.5	10.8	8.3	7.5	8-7-9=6-5
13650	♀	Near Pilot Knob, Calif. side	May 11	57.8	42.0	18.1	10.4	8.1	7.6	8-7-9-6-5
		Average of the 6 ♀♀		58.6	42.4	18.2	10.8	8.0	7.3	

[1] See text, pages 157, 196. [2] See text, page 197. [3] Defective.

Dendroica aestiva brewsteri Grinnell

California Yellow Warbler

Appeared as a migrant through the willow bottom, individuals at large being distinguished from the breeding *D. a. sonorana* by their silence. Five specimens taken, nos. 13653–13657, bear locality and date as follows: Male, California side, twenty miles north of Picacho, April 12; male and female, same side, five miles northeast of Yuma, May 4; male and female, same side, near Pilot Knob, May 9 and 6, respectively.

Dendroica aestiva rubiginosa (Pallas)

Alaska Yellow Warbler

A late migrant along the willows, secured only on the California side near Pilot Knob; two specimens: male, no. 13651, May 9; female, no. 13652, May 14.

Dendroica auduboni auduboni (Townsend)

Audubon Warbler

Varyingly common as a winter visitant or transient on either side of the river from the first day of our work, February 15, and from our first station, Needles, until the last day of our work at our last station, May 15, at Pilot Knob. Full-plumaged males were still noted on the latter date, which would indicate unexpectedly late migration. The species was seldom noted outside of the willow association, and then only a short distance away, in the mesquite or a little beyond. Twenty-five specimens were taken, nos. 13658–13682.

There is also in the Museum a skin (no. 4257) taken by J. G. Cooper at Fort Mohave, February 24, 1861.

Dendroica nigrescens (Townsend)

Black-throated Gray Warbler

First seen April 2, on the California side opposite Cibola, a solitary female. Next seen on the Arizona side ten miles below Cibola April 9, a male; then more frequently, sometimes in small droves with other warblers, twenty miles north of Picacho, eight miles east of Picacho, five miles north of Laguna, four miles south of Potholes and at Pilot Knob. The last one was noted at the latter place May 9. The species

was noted all along only in willows or mesquites. Seven specimens taken, nos. 13683–13689. Evidently occurs through the region as a migrant only.

Dendroica townsendi (Townsend)

Townsend Warbler

First noted April 26, on the Arizona side five miles north of Laguna, two seen and another secured. At Potholes, April 28 and 29, fully twenty-five were noted; four miles south of Potholes May 2 one was taken, and another five miles northeast of Yuma, May 4. In the vicinity of Pilot Knob several were seen May 13 and 14. At every other place the birds were exclusively in the willows, but here they were in arrowweed as well. Evidently a transient. Nine specimens taken, nos. 13690–13698.

Dendroica occidentalis (Townsend)

Hermit Warbler

First observed, a male, April 20, on the California side, eight miles east of Picacho; next, a male, on the Arizona side five miles north of Laguna, April 25; then at Potholes on the 28th and 29th, several; five miles northeast of Yuma, May 3, a male; and near Pilot Knob, May 9, a female. A through migrant. Six specimens taken, nos. 13699–13704.

Oporornis tolmiei (Townsend)

Tolmie Warbler

First noted, a male, April 12, on the California side of the river, twenty miles north of Picacho. Next observed, in numbers, both sexes, April 25 and 26, on the Arizona side five miles above Laguna. Then, on the California side, almost daily in varying numbers, at Potholes, four miles below Potholes, five miles northeast of Yuma, and in the vicinity of Pilot Knob. The species was still common in the latter locality, May 14.

In all the above places, the species adhered closely to the arrowweed and quailbrush associations, frequently visiting the water's edge through the willows, especially during midday. The brush associa-

tions are preferred doubtless because nearest like their summer associational habitat. Ten specimens taken, nos. 13705–13714.

There is also in the Museum a skin (no. 4255) taken by J. G. Cooper at Fort Mohave, April 24, 1861.

Geothlypis trichas scirpicola Grinnell

Tule Yellowthroat

A cursory glance at the sixteen specimens of yellowthroats obtained shows clearly that as regards size and color two diverse types are represented. Observation in the field showed that there were two categories as regards behavior. And these two assortments, as far as data justifies, appear to coincide; namely, the smaller, grayer and duller birds were quiet, and doubtless migrating, while the larger, more brightly colored birds were in full song, evidently the breeding subspecies. Both forms were found in the densest available cover, the resident birds, however, being always met with in the immediate vicinity of water, while some of the migratory individuals were in quail-brush on the second bottom many rods from the river or nearest slough. It was, of course, impossible to distinguish the forms by appearance in the field: in fact, some of the specimens themselves are only with difficulty and some uncertainty placed in one or the other category.

After an independent study of the Museum's series of yellowthroats from the western United States, British Columbia and Alaska, I have arrived at the same conclusions as expressed by Swarth (1912, p. 72). These conclusions are that there is no recognizable Pacific coast race (*arizela*), the name *occidentalis* applying rightly to all breeding yellowthroats of North America west of the great plains, except those of the San Francisco Bay region (*G. t. sinuosa*) and those of southern California and Arizona (*G. t. scirpicola*).

The breeding males of the Colorado Valley agree with those of southern Arizona and the San Diego district in southern California, and differ from *occidentalis* in large size throughout, and in brighter coloration. The latter feature consists in a deeper toned yellow below and an extension of this yellow posteriorly to include the abdominal area; in brighter yellow of the crissum; in the flanks being washed with a darker tone of clay color; in the dorsum being pervaded with golden yellow instead of being of a grayish cast, as in *occidentalis;* and in the grayish area on the head bordering the black mask posteriorly

being very broad, tending to cover in some cases the whole pileum, though becoming concealed beneath an olive wash posteriorly, and with a mixture of yellow.

Extreme examples of *scirpicola* are conspicuously different from the nearest approach to it in appearance among many specimens of *occidentalis* from Nevada, northern California, British Columbia and southeastern Alaska. But among the considerable number of specimens from the range of *scirpicola*, there are some which have so far defied every effort to distinguish them satisfactorily from *occidentalis*. The problem is complicated by the fact that there are yellowthroats moving through the range of *scirpicola* at the same season that the resident birds are nesting, that is, until the last week in April at least.

The twelve Colorado Valley examples referred to *scirpicola* (characterized by Grinnell, 1901, p. 65) are listed in an accompanying table to show locality and date of capture, and measurements. One specimen, no. 13723, deserves special comment because of an extraordinary aberrancy in coloration: the whole throat is clear, intense cadmium yellow, in marked contrast with the normal canary yellow of the chest and remaining lower parts; otherwise the bird is like the average. This extra intensification towards orange, though over a restricted area, is probably a color change of significance along the same line as discussed in this paper under *Colaptes chrysoides*.

The tule yellowthroat was closely restricted to dense vegetation growing close beside or over water. Tules bordering sloughs formed

MEASUREMENTS IN MILLIMETERS OF *GEOTHLYPIS TRICHAS SCIRPICOLA* FROM THE COLORADO VALLEY

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Culmen
13720	♂	Riverside Mt., Calif. side	Mar. 18	57.7	54.5	20.0	11.1
13721	♂	Riverside Mt., Calif. side	Mar. 20	56.5	52.8	20.3	11.0
13723	♂	Ehrenberg, Ariz. side	Mar. 29	55.1	53.3	19.7	11.8
13728	♂	5 mi. N. Laguna, Ariz. side	Apr. 25	53.9	50.5	20.9	11.5
13729	♂	4 mi. S Potholes, Calif. side	May 2	57.0	52.1	20.0	11.2
13731	♂	5 mi. N.E. Yuma, Calif. side	May 4	54.2	51.2	20.4	.....
13732	♂	5 mi. N.E. Yuma, Calif. side	May 3	58.6	56.7	20.2	11.6
13733	♂	5 mi. N.E. Yuma, Calif. side	May 4	57.3	53.6	20.5	12.1
13734	♂	Near Pilot Knob, Calif. side	May 6	58.9	56.6	.....	11.8
13735	♂	Near Pilot Knob, Calif. side	May 14	57.5	55.0	20.8	12.0
		Average of the males,		56.6	53.6	20.3	11.5
13725	♀	Opposite Cibola, Calif. side	Apr. 1	53.5	49.5	19.8	11.9
13730	♀	4 mi. S. Potholes, Calif. side	May 2	54.8	49.3	20.2	11.7

the usual habitat. Occasionally dense growths of very young willows, being then similar in habit to tules, offered the proper conditions. Along the lower course of the river, thickets of cane which clothed the abrupt banks were the chief resort. Where tules failed, as near Pilot Knob, this was the only accepted cover. On April 17, as we floated through Canebrake Cañon, three to seven miles below Picacho, the songs of yellowthroats were heard almost continually. Here they were inhabiting the jungles of cane which grew down into the river along both shores. Unfortunately we did not have the time to devote to search for nests, and information in regard to breeding habits is lacking.

Geothlypis trichas occidentalis Brewster

Western Yellowthroat

Occurred as a migrant along the valley, as noted under the preceding heading. The four specimens taken and referred to this subspecies are all males, and were obtained as follows: No. 13722, Blythe, California side, March 23; 13724, ten miles below Cibola, Arizona side, April 9; 13726, 13727, twenty miles north of Picacho, California side, April 11 and 12. These migrants were quite likely bound for the Great Basin to the northward, being indistinguishable from specimens from northern Nevada.

Icteria virens longicauda Lawrence

Long-tailed Chat

First seen April 25, above Laguna, one individual; three in the same place the next day. On the 27th, at Potholes, several were seen; and thenceforth, at Potholes and four miles below, five miles northeast of Yuma, and on both sides of the river in the vicinity of Pilot Knob, chats were abundant. Twenty-four specimens were taken, nos. 13769–13792.

There is in the Museum a skin (no. 6423) taken by J. G. Cooper at Fort Mohave, April 25, 1861.

This bird was everywhere closely confined to the willow association, at any rate never seen beyond the arrowweed. In point of actual numbers, they were probably not so numerous as yellow warblers or song sparrows; but in volume of noise they exceeded all other birds combined. These chats of the Colorado possess an amazingly large vocabulary in imitation of other sounds. On May 3 a few minutes of

attention to a single individual was enough for unmistakable recognition of notes or songs of Abert towhee, flicker, kingfisher, Bullock oriole, and tanager. The chat is here a far better mocker than the mockingbird itself.

Wilsonia pusilla pileolata (Pallas)

Alaska Pileolated Warbler

Appeared commonly as a migrant through the riparian strip. Sixteen specimens (nos. 13736–13751) were taken, from April 19 to May 12, inclusive, representing the following localities: California side, eight miles east of Picacho, April 19 and 20; Arizona side, five miles north of Laguna, April 21, 24 and 25; California side at Potholes, April 27; same side, four miles south of Potholes, May 1 and 2; same side, five miles northeast of Yuma, May 4; same side near Pilot Knob, May 8 and 12.

Wilsonia pusilla chryseola Ridgway

Golden Pileolated Warbler

Common as a migrant, through the riparian strip. First seen March 9 and 10, one each day, on the California side in Chemehuevis Valley. Next noted March 20, one taken, near Riverside Mountain; thenceforth of almost daily observation in suitable places at nearly all stations until May 2, when the last one with certainty identified was taken on the California side four miles below Potholes. Intermediate points and dates of capture were: California side above Blythe, March 23; Arizona side below Ehrenberg, March 26; ten miles below Cibola, Arizona side, April 7, 8 and 9; California side twenty miles north of Picacho, April 11 and 12; same side, eight miles east of Picacho, April 18 and 20; Arizona side, five miles above Laguna, April 25 and 26; four miles below Potholes, April 30, as well as May 2, as noted above. The series of specimens taken consists of seventeen examples (nos. 13752–13768).

At times pileolated warblers were numerous in tracts of willow, but since it was impossible to distinguish between the race *pileolata* and the race *chryseola* without shooting, the proportion present of these two forms between April 19 and May 2 could not be judged. All individuals shot were, however, preserved. Between these dates, thirteen *pileolata* were taken and seven *chryseola*. This proportion, nearly

two to one, for this period may therefore be near the truth. But it is further observable from the data presented that *pileolata* was a later migrant through this region than *chryscola*.

Anthus rubescens (Tunstall)

Pipit

At the time of our arrival at Needles, February 15, pipits were numerous close along the river, both on the grassy areas near the Indian camp and on the mud bars at the water's edge. They were thenceforth observed through March at many points along the river on both sides, especially when we were floating down from station to station. They were still common the first week of April, opposite Cibola. But none were seen later than April 8, when a single bird was noted flying up river, ten miles below Cibola.

Five specimens taken, nos. 13715–13719.

Oreoscoptes montanus (Townsend)

Sage Thrasher

Observed only on March 23 and April 2 and 3, so probably a transient purely. On the first specified date three were noted on the California side, above Blythe. On the latter two days fully a dozen were encountered on the same side opposite Cibola. In each case the birds adhered closely to mistletoe-bearing mesquite and ironwood, the latter extending up the desert washes. Four specimens taken, nos. 13793–13796.

Mimus polyglottos leucopterus (Vigors)

Western Mockingbird

Common early in the season all along the river on both sides. Almost exclusively confined to the mesquite belt and to the ironwoods a short distance up washes, especially where these trees were laden with mistletoe. The berries of this parasite appeared to be the chief or only food of the mockingbird.

Mockingbirds were especially common the last week in February in company with robins, bluebirds, and phainopeplas in the mesquite belt near Mellen, Arizona. The day (March 15) we floated down from our last station above the mouth of Bill Williams River to Parker, we heard the singing of mockingbirds from either side of the

Colorado River at frequent intervals all along. At Riverside Mountain and above Blythe, on the California side, they were still common. A few were noted the first week in April on the California side opposite Cibola. Three individuals were seen on the Arizona side ten miles below Cibola, April 9, and the last for the season were noted April 19, eight miles east of Picacho. Nine specimens of the mockingbird were secured (nos. 13797–13805), one on this latest day.

There were no indications, either through dissection or judging from the behavior of the many birds observed, that the species nests in the region. It appears most probable that the species is only a winter visitant from the higher Upper Sonoran Zone to the northward in eastern California and southern Nevada.

Toxostoma crissale Henry

Crissal Thrasher

A very characteristic element of the fauna of the Colorado bottom along the whole portion of its course explored by us. All evidence shows that it was a permanent resident, and closely restricted at all times to the outermost riparian association, namely the mesquite belt. Wherever this belt was strongly represented, the presence of crissal thrashers was to be recognized through their song or call note. But it was a difficult matter to shoot specimens, as the birds were ever alert, and kept close to or upon the ground beneath dense cover. Locally the thrashers were found foraging among catclaws and ironwoods up desert washes within a mile of the river bottom, and in some places they had temporarily forsaken the mesquites and invaded the willow tracts. The total absence of mesquite in any section of the river valley, however, was a sure indication of the absence of thrashers.

The species was noted at the following localities: California side, five miles below Needles; Arizona side, above Mellen (more numerous than at any other point); both sides of the river in the vicinity of The Needles; Arizona side above Bill Williams River; California side at Riverside Mountain, above Blythe, opposite Cibola, twenty miles above Picacho, and eight miles east of Picacho; Arizona side, five miles above Laguna; and California side in the vicinity of Pilot Knob. Mellen was the only station where definite indications of breeding were found. A female taken February 24 showed conclusively that incubation was in process; and another contained large ova. Still no young-of-the-year were encountered during the succeeding two and one-half months.

Twelve specimens of the crissal thrasher were preserved, nos. 13806–13817.

There is also a specimen in the Museum (no. 4226) taken by J. G. Cooper at Fort Mohave, January 2, 1861; and another (no. 6112) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 20, 1864.

Heleodytes brunneicapillus couesi (Sharpe)

Cactus Wren

Met with in small numbers at most of the collecting stations. Where desert washes led down to the river bottom, cactus wrens occurred locally in the mesquite belt; but otherwise the species was restricted to the neighborhood of tracts of ironwood, catclaw, and cactus back from the river. In other words, it was a desert species, not properly a member of the riparian assemblage.

This wren was evidently resident wherever found, as nests were always to be seen in the vicinity. Specific points of occurrence were: in the Sacramento Wash near Mellen; both sides of the river in the vicinity of The Needles; Arizona side above Bill Williams River; California side at Riverside Mountain; and same side above Blythe, opposite Cibola, twenty miles above Picacho, eight miles east of Picacho and four miles north of Potholes. At the latter place in a wash in the giant cactus belt, about two miles back from the river, a nest was found April 23 containing four eggs in which incubation was far advanced. The nest was of usual construction, and was situated five feet above the ground in a dense cholla cactus. Other nests were seen at different points, in ironwood, palo verde and mesquite.

Nine specimens of the cactus wren were taken, nos. 13818–13826.

Salpinctes obsoletus obsoletus (Say)

Rock Wren

Up to the middle of March common widely on the desert mesas as well as among hills. Noted at every station from the vicinity of Needles and Mellen south to Riverside Mountain. Thenceforth observed only in pairs in restricted localities affording appropriate nesting sites. On the California side opposite Cibola, April 3, a pair of rock wrens were found in a ravine about two miles from the river. Their nest was located in a hole in the rock wall of a gully, only about five feet from the bed. The floor of the opening, and also of some

adjacent cavities, was paved with flat pieces of stone about an inch in diameter. The nest itself was out of reach. Several rock wrens were observed among the hills twenty miles north of Picacho. On April 16 a bird was observed to fly into a cranny with a bill full of insects, thus indicating young at this date. A bird taken on the hillside near Potholes, April 27, showed evidences that the breeding season was past.

Five specimens were secured (nos. 13841–13845).

There are also in the Museum two skins (nos. 4277, 4278) taken by J. G. Cooper at Fort Mohave, January 31 and February 10, 1861.

Catherpes mexicanus conspersus Ridgway

Cañon Wren

Observed only where precipitous rock walls furnished the ideal environs for the species, and only sparingly then. At least three pairs were located on the river side of the pinnacles constituting The Needles, and one specimen obtained March 5. Another pair was observed on the California side opposite. The song was heard repeatedly as we passed through the whirlpool cañon just below The Needles. Again met with in deep, narrow ravines in some red conglomerate hills above Bill Williams River, where one example was taken March 15 and another seen. From the cañon walls on either side of the river in its course immediately below the mouth of Bill Williams River, the song of this wren came often to our ears as we drifted along.

March 17 and 18 cañon wrens were heard in ravines well up on Riverside Mountain. As none were seen after the latter date, although other favorable localities were visited, it is possible that the species is only a winter visitant to the region from the higher desert ranges in the Death Valley region. Still it is known to breed in similar localities in the same life-zone elsewhere.

The two examples secured (nos. 13848, 13849) are doubtfully referred to *conspersus*. Lack of material prevents a satisfactory study of the case.

Thryomanes bewicki eremophilus Oberholser

Desert Bewick Wren

Common as a winter visitant to the region. Observed chiefly in the sparse brush margining the washes leading down from the desert interior. The catclaw and larger creosote bushes appeared to afford

both productive foraging grounds and safe retreats. It was rarely that this wren was seen near the river, and then only as far as the salt-bush belt. The range of the western house wren in the willow association appeared to be not at all impinged upon by that of the desert Bewick wren. This again shows the local dissociation of birds of the same or nearly the same habits, even in their winter habitats. It is to be inferred that there are inherent preferences of the two species for cover of the two different sorts.

The desert Bewick wren was observed on the California side five miles below Needles, opposite The Needles, and in the lower Chemehuevis Valley; on the Arizona side in the vicinity of Mellen, at the foot of The Needles, and above Bill Williams River. At least one specimen was secured at each of the above points. The last for the season were observed March 21 at Riverside Mountain. The series of nine specimens (nos. 13827–13835) are uniform in their exhibition of the characters assigned to this race by its original describer (Oberholser, 1898, p. 427). The great length of tail alone serves to distinguish *Thryomanes bewicki eremophilus* from any of the other seven forms of *bewicki* occurring within the state of California (Grinnell, 1910, p. 309). The Colorado Valley birds are with a high degree of probability visitants from a summer habitat lying on the higher desert mountains in the vicinity of Death Valley, California and Nevada, where this form has been recorded as breeding (Oberholser, 1898, p. 429).

There are in the Museum three skins (nos. 4280–4282) of this wren taken by J. G. Cooper at Fort Mohave, January 1, March 6 and 21, 1861.

Troglodytes aëdon parkmani Audubon

Western House Wren

Common as a winter visitant to the river bottom only, and even here confined almost exclusively to the willow association. Not one individual was seen anywhere on the desert proper. The species was noted in the willow thickets near Needles, February 15, and thenceforth at all stations, on both sides of the river, until the last of March. At Ehrenberg but one was noted (and obtained) March 29. The last for the season was seen April 9, a single individual, in a pile of drift on the river bank on the Arizona side ten miles below Cibola.

Five specimens preserved (nos 13836–13840).

There is also a skin in the Museum (no. 4287) taken by J. G. Cooper at Fort Mohave, January 22, 1861.

As there are no known characters by which to recognize house wrens breeding in the Great Basin region from those on the Pacific coastal slope, there is no way of deciding where those individuals wintering in the Colorado Valley come from. But it is most likely that they hail from the interior somewhere, as do practically all of those birds where this point can be definitely determined.

Telmatodytes palustris plesius (Oberholser)

Western Marsh Wren

Observed only in dense but low vegetation such as tules, along lagoons in the river bottom. A single example was seen and secured (no. 13846) on the California side at the lower end of Chemehuevis Valley, March 11. Near Riverside Mountain March 17 several were seen, and one secured (no. 13847). On the Arizona side a mile or so below Ehrenberg, March 25 to 29, there were many around a series of ponds. Nothing was seen of the species after the latter date. Since no old nests or other indications of breeding were detected, it is not to be presumed that marsh wrens are more than winter visitants to the Colorado Valley.

Auriparus flaviceps flaviceps (Sundevall)

Verdin

The most numerous and widespread resident species of bird in the whole region. The only essential condition for the presence of this species appeared to be stiff-twigged thorny bushes or trees of some sort. This requisite was met with in a variety of situations, as in the screwbeans of the first bottom, mesquites of the second bottom, and catclaw, ironwood, palo verde and daleas of the desert washes. The birds appeared to have already paired off by the latter half of February; each pair had a particular beat or forage area, focussing at one or more nests. Nests were occupied, at least as roosting places, throughout the season, and as nests were not constructed in other than the thorny bushes above named, the local range of the species was predetermined. While the birds were often seen in willows, arrowweed, and even low shrubs of *Atriplex* and sandburr, these were

always within a limited radius of nests. As far as observation went, these birds do not need to visit water; some were met with as much as three miles away from the river up desert washes.

Nests containing eggs or young were found as follows: April 5, California side opposite Cibola, eggs four, incubation advanced; April 7, Arizona side ten miles below Cibola, eggs four, incubation far advanced; same date and place, three eggs incubated and one newly hatched young; same date and place, eggs five, incubation nearly complete; April 11, California side, twenty miles above Picacho, eggs four, incubation advanced; April 12, same place, three small young and one egg about to hatch; April 22, on the Arizona side five miles above Laguna, a brood of two-thirds grown young was encountered. The breeding period thus would appear to be of remarkable uniformity among all individuals of the species.

The above six nests varied from 38 to 96 inches above the ground, averaging 69 inches. These, of the usual firm-walled, globular type and constructed of stiff, thorny twigs, with the laterally placed opening scarcely larger than the diameter of the bird, would thus appear admirably adapted for the exclusion of the parasitic cowbird, of much greater size, as well as a defence against depredators of various sorts. I can see no other reason for so specialized a structure. Yet the plumbeous gnatcatcher, occupying almost an identical range, and with *open* nests, lays the same number of eggs, as though it were no more subject to fatalities than the verdin. This is true also of the Sonora yellow warbler (see Brown, 1903, p. 47).

A series of twenty-four verdins was taken, nos. 13922–13945. Two of our specimens, taken at Needles February 15 and 16, are much discolored with coal soot.

Besides these, there are in the Museum collection five specimens (nos. 4238–4242) taken in 1861 by J. G. Cooper at Fort Mohave. The dates of capture are: February 19, March 9, 15 and 30, and April 5. These old skins are perceptibly paler than the freshly obtained specimens, most probably due to their having been exposed to strong light in a show case at some time or other.

Regulus calendula cineraceus Grinnell

Ashy Kinglet

Evidently a characteristic winter visitant, as it was one of the commonest birds of the willow bottom in the vicinity of Needles at the time of our arrival in the region, February 15. It was thenceforth

noted regularly down along the river until the first week in April, when it became scarce; the last one noted was secured April 18, on the California side eight miles east of Picacho, this being the only individual seen at this point. The other localities of capture, lying between the two above-named, are as follows: on the California side: opposite The Needles, Chemehuevis Valley, Riverside Mountain, Blythe, opposite Cibola, twenty miles north of Picacho; on the Arizona side: Mellen, foot of The Needles, Ehrenberg, ten miles south of Cibola. In all these places the kinglets were seldom seen outside of the willow association.

The series of twenty-four specimens obtained, nos. 13946–13969, is uniform in its exhibition of the characters assigned to *Regulus calendula cineraceus* (see Grinnell, 1904, p. 25). As compared with examples from eastern North America, they are distinctly more ashy-hued anteriorly both above and below. Especially is this peculiarity marked over the top and sides of the head. There is a slightly greater general size in the case of the southwestern race. It is therefore probable that the Colorado River birds are visitants from the mountains of the southwest, whence kinglets of the same characters have been secured in summer, rather than from the forests of the far north.

There is also in the Museum a skin (no. 4272) taken by J. G. Cooper at Fort Mohave, January 18, 1861.

Polioptila caerulea obscura Ridgway

Western Gnatcatcher

First seen at Needles, February 16; thenceforth noted regularly at all stations along down the river until April 6, when the last were noted ten miles below Cibola. As the specimens taken the first week in April, when *Polioptila plumbea* was nesting, showed no signs of immediate breeding, it seems probable that the western gnatcatcher is only a winter sojourner in the Colorado Valley. It occurred chiefly in the bushes lining the desert washes leading back from the river; a few individuals were met with in the mesquite and willow associations.

The series of thirteen skins preserved (nos. 13874–13886) represent the following localities: California side, five miles south of Needles; both sides of the river at The Needles; California side at Riverside Mountain and opposite Cibola; and Arizona side, ten miles below Cibola.

There is also in the Museum collection a skin (no. 4216) taken by J. G. Cooper at Fort Mohave, March 26, 1861.

The spring molt (which involves only the body plumage) is well along in the bird (a male) of the latter date and in birds of April 4, 5 and 6 appears to be nearly or quite complete. In the females of these dates there is, however, a want of clearness and continuity in the gray of the dorsum and pileum, and upon close examination this is found to be due to an interrupted and irregular replacement of feathers. This results in a mixture of new clear gray feathers and worn ashy ones.

Of the April birds there are six females and one male. The latter (no. 13882), in comparison with series of *Polioptila caerulea obscura* from western California, has an extraordinary amount of black on the forehead, there being a frontal band of an approximate width of five millimeters, with a conspicuous extension posteriorly over each eye. Moreover, two of the females (nos. 13880, 13881) show a distinct supra-loral black line on each side, the two lines converging and meeting over the base of the culmen. This tendency to blackness on the crown may characterize a race wintering in the Colorado Valley and breeding in the Upper Sonoran zone of desert mountains to the northwestward. Material is not at hand to permit following up the matter.

Polioptila plumbea (Baird)

Plumbeous Gnatcatcher

A common resident along the whole line of exploration from Needles to the Mexican line. The series of thirty-five specimens secured (nos. 13887–13921) represents the following localities: California side, at Needles and five miles below Needles; Arizona side, above Mellen and at the foot of The Needles; California side in Chemehuevis Valley, at Riverside Mountain and above Blythe; Arizona side, at Ehrenberg; California side, opposite Cibola, twenty miles above Picacho, eight miles east of Picacho, and near Pilot Knob.

There are also in the Museum two skins (nos. 4219, 4220) taken by J. G. Cooper at Fort Mohave, February 19 and March 19, 1861.

The desert wash association, with its catclaw, palo verde, ironwood and smaller woody and stiff-twigged plants, was the preferred habitat of this bird, though it occurred also in the *Atriplex* and mesquite belts along the river, even straying occasionally into the arrowweeds and

willows. It did not, however, seem to visit water, and so its presence did not at all depend upon the proximity of the river.

April 19, on the California side, eight miles east of Picacho, a nest was found in a smoke-bush (*Dalea*). It was four feet above the ground, of usual structure, and contained five small young. April 23, on the same side, four miles above Potholes, a brood of nearly grown young was flitting about at large. The breeding time in this region is thus indicated.

Hylocichla ustulata ustulata (Nuttall)

Russet-backed Thrush

As elsewhere in the west this bird proved to be a late arrival. The first individuals were noted May 4 and 5, five miles northeast of Yuma, one each day. On both sides of the river in the vicinity of Pilot Knob, May 9 to 15, the species was of frequent observation, chiefly at daybreak in the willows close along the river. One was seen, however, in a rocky ravine on Pilot Knob itself, towards late evening of the 14th. The species is most certainly only a transient through the region. The three specimens taken (nos. 13850–13852) are unequivocally referable to *H. u. ustulata*.

Hylocichla guttata guttata (Pallas)

Alaska Hermit Thrush

Hermit thrushes proved not to be characteristic winter visitants, as expected, and they were rare even as migrants. Unmistakable notes of one were heard at daybreak from a willow thicket in Chemehuevis Valley, March 9. Heard again similarly, ten miles below Ehrenberg, March 31. A single individual secured (no. 13853) on the California side twenty miles north of Picacho, April 10. This bird, the last of the species noted, was in a dense willow growth close to the river. The specimen is identical, in size and coloration, with examples of this race from the Prince William Sound region of Alaska.

Hylocichla guttata nanus (Audubon)

Dwarf Hermit Thrush

There is in the Museum a skin (no. 6432) taken by J. G. Cooper at Fort Mohave, January 25, 1861. Although obviously faded on its ventral surface, by size and dorsal color this specimen is distinctly referable to *nanus*.

Planesticus migratorius propinquus (Ridgway)

Western Robin

Fairly common as a winter visitant to the bottom lands. Often met with in the dense willow woods, on the ground foraging for insects in the layers of dead leaves. Also one of the regular feeders on mistletoe berries. At Needles, California, February 17, several individuals were seen hopping about on the grass in the railway parking. On the Arizona side above Mellen a number were found among the mistletoes of the mesquites, February 23 to 31. A few were encountered on each side of the river at The Needles, March 1 to 7. One was seen March 14, on the Arizona side above Bill Williams River; a few on the California side at Riverside Mountain, March 17 to 21; several on the same side opposite Cibola, April 1 to 5; and one, the last noted, on the Arizona side, ten miles below Cibola, April 7.

Seven specimens secured, nos. 13854–13860.

There is also in the Museum a skin (no. 4224) taken by J. G. Cooper at Fort Mohave, March 7, 1861.

Sialia mexicana occidentalis Townsend

Western Bluebird

Common, as a winter visitant, feeding in flocks on mistletoe berries wherever these were obtainable, usually in the mesquite belt. Numerous at Needles, California, and immediately below, February 14 to 22; at and above Mellen, Arizona, February 23 and 31; and on both sides of the river at The Needles, March 1 to 7. The species was last seen, a very few, March 13, on the Arizona side above Bill Williams River.

There is a skin (no. 4212) in the Museum taken by J. G. Cooper at Fort Mohave, February 22, 1861.

The thirteen specimens secured by us (nos. 13861–13873) are not exactly typical of *S. m. occidentalis*, as occurring in the northwest coast district of the United States. Yet I do not find grounds for allocating them with *S. m. bairdi*, of the Rocky Mountain area, nor with *S. m. anabelae* of northern Lower California. They are very much like birds from the Sierra Nevada, and I have little doubt are winter visitants to the Colorado Valley from there. Sierra Nevada birds are customarily referred to *S. m. occidentalis*, and at present I cannot do anything better than employ this name for the specimens in hand. Coloration furnishes characters difficult to weigh properly,

because of much seasonal variation in tone of browns and blues through fading and abrasion, and because of wide individual variation in extent of chestnut areas. General size, too, is an inconstant feature (see Grinnell and Swarth, 1913, p. 318).

CHECK-LIST OF MAMMALS

1. Ovis canadensis nelsoni Merriam
2. Odocoileus hemionus eremicus (Mearns)
3. Ammospermophilus harrisi harrisi (Audubon and Bachman)
4. Ammospermophilus leucurus leucurus (Merriam)
5. Citellus tereticaudus tereticaudus (Baird)
6. Castor canadensis frondator Mearns
7. Peromyscus maniculatus sonoriensis (Le Conte)
8. Peromyscus crinitus stephensi Mearns
9. Peromyscus eremicus eremicus (Baird)
10. Sigmodon hispidus eremicus Mearns
11. Reithrodontomys megalotis deserti J. A. Allen
12. Neotoma albigula venusta True
13. Neotoma intermedia desertorum Merriam
14. Ondatra zibethica pallida (Mearns)
15. Thomomys chrysonotus Grinnell
16. Thomomys albatus Grinnell
17. Dipodomys deserti deserti Stephens
18. Dipodomys merriami merriami Mearns
19. Perognathus bombycinus Osgood
20. Perognathus formosus Merriam
21. Perognathus penicillatus penicillatus Woodhouse
22. Perognathus intermedius Merriam
23. Perognathus spinatus spinatus Merriam
24. Lepus californicus deserticola Mearns
25. Sylvilagus auduboni arizonae (J. A. Allen)
26. Felis oregonensis browni Merriam
27. Lynx eremicus eremicus Mearns
28. Canis ochropus estor Merriam
29. Vulpes macrotis arsipus Elliot
30. Urocyon cinereoargenteus scotti Mearns
31. Mephitis estor Merriam
32. Spilogale arizonae arizonae Mearns
33. Taxidea taxus berlandieri Baird
34. Procyon pallidus Merriam
35. Corynorhinus macrotis pallescens Miller
36. Antrozous pallidus pallidus (Le Conte)
37. Myotis occultus Hollister
38. Myotis californicus pallidus Stephens
39. Myotis velifer (J. A. Allen)
40. Pipistrellus hesperus hesperus (H. Allen)
41. Eptesicus fuscus (Beauvois)
42. Nyctinomus mexicanus Saussure
43. Macrotus californicus Baird

GENERAL ACCOUNTS OF THE MAMMALS: LOCAL DISTRIBUTION, VARIATION, HABITS

Ovis canadensis nelsoni Merriam

Desert Bighorn

Mountain sheep still occur in parts of the country on both sides of the river. Among The Needles, on the Arizona side, March 5, fresh feces and footprints showed plainly where a band of at least five had been grazing. The point of this occurrence was not more than half a mile from the river and 300 feet in elevation above it.

We were assured of the existence of a flock of fully thirty-five sheep on the Arizona side east of Cibola. These sheep were reported to visit regularly certain springs in the Chocolate Mountains.

On the California side, as we were informed, sheep used to range over Riverside Mountain, but they have not been seen there of late years, probably because of the mining activity in that vicinity. Prospectors told us that they had always taken every opportunity to obtain "fresh meat" wherever they might be in the desert hills; and as the camps of the prospectors are usually made at the water holes which the sheep depend upon in the long, dry seasons, it is not difficult to account for the disappearance of sheep in a mineralized region!

West of the river, 16 to 22 miles above Picacho, we found sheep to be quite common. At least five had been killed within the previous year by residents along the river. Two of these were shot from a rancher's house and within a few hundred yards of the river, which here flows between steep hills, with relatively little bottomland intervening. This, by the way, is in the near vicinity of Lighthouse Rock, and in the sketch of the river including this landmark, given in Ives' *Report upon the Colorado River of the West* (1861, page 52, figure 7), two unmistakable bighorns are portrayed at the water's edge.

We learned nothing to indicate that the sheep in this neighborhood ever visit the river for water at the present time. There are springs back in the hills to which the sheep regularly resort. We saw five sheep, and secured two, a ewe (no. 10588) and a male lamb (no. 10589). These were found about three miles west of the river among rough hills.

There is a possibility that the bighorns on the Arizona side of the Colorado differ slightly from those on the California side. The latter unquestionably belong to the race *nelsoni*. Mearns (1907, p. 240) describes a race (*Ovis canadensis gaillardi*) from the Gila Mountains, Yuma County, Arizona. This locality is less than seventy-five miles from the locality near Cibola where sheep are known to occur, and if *gaillardi* is a really distinct form the sheep of Cibola are perhaps referable to it rather than to *nelsoni*.

Odocoileus hemionus eremicus (Mearns)

Burro Deer

No trace of deer was found by us anywhere, nor had anyone we talked with seen deer along the Colorado within four years. We were told of their occurrence in numbers many years before, when they were to be found both in the river bottom and back through certain desert ranges, where there are springs which the deer could visit regularly for water.

In August, 1902, Mr. Frank Stephens saw two deer on the California side of the river west of Cibola. The animals were jumped from a wash among ironwood trees and made off across a wash. Sign was fairly plentiful, and deer were said to be common at that time on both sides of the river.

Members of our party in 1910 looked over the same ground closely without finding sign. The rapid settlement of the river bottom around Palo Verde probably accounts for the disappearance of deer throughout that section. At the Draper ranch twenty miles above Picacho a single old buck had been seen "about" five years previously.

Ammospermophilus harrisi harrisi (Audubon and Baehman)

Harris Ground Squirrel

Twenty-six specimens secured, from localities all on the Arizona side of the river, as follows: Mellen, 18; foot of The Needles, 1; above Bill Williams River, 2; Ehrenberg, 3; 10 miles below Cibola, 2. None was seen at any locality where not also taken, so that the species appears not to occur near the river along its course below Cibola. Our work shows, further, an extreme associational restriction, namely, to rupestrine conditions as furnished in the rough hills and on those parts of the desert mesa where the wind keeps the weathered detritus

removed, leaving a surface of firmly packed gravel or pebbles. The burrows of the Harris ground squirrel are most often to be found opening out beneath a creosote bush (see pl. 12, fig. 18), which plant occurs throughout the range of the squirrel. Up to the last date of capture, April 9, no young had been observed, although on March 5, at Mellen, a female taken contained six embryos.

In no instance was this rodent found to have strayed on to any part of the river bottom, even on to the edge of the sandy second bottom. But where the river passed among the steep-sided hills, as at

LIST AND MEASUREMENTS IN MILLIMETERS OF *AMMOSPERMOPHILUS HARRISI HARRISI* FROM THE ARIZONA SIDE OF THE COLORADO RIVER

Mus. No.	Sex	Locality	Date, 1910	Total length	Tail vertebrae	Hind foot	Ear	Occipito-nasal length of skull	Zygomatic width
10531	♀	Near Mellen	Feb. 25	225	70	39	5	38.8	22.0
10532	♂	Near Mellen	Feb. 26	246	85	40	5	40.4	23.7
10533	♂	Near Mellen	Feb. 27	226	84	40	8	39.3	22.5
10534	♀	Near Mellen	Feb. 27	217	76	39	8	38.5	22.0
10535	♂	Near Mellen	Feb. 27	232	70	40	..	39.4	22.6
10536	♀	Near Mellen	Feb. 27	215	70	38	..	38.4	22.1
10537	♂	Near Mellen	Feb. 27	222	66	37	..	38.5	22.2
10538	♀	Near Mellen	Feb. 27	225	70	40	..	39.7	22.5
10539	♂	Near Mellen	Feb. 27	224	68	39	..	40.8	23.5
10540	♂	Near Mellen	Feb. 27	243	80	40	..	40.1	22.5
10541	♀	Near Mellen	Feb. 28	205[1]	50[1]	39	..	38.7	22.5
10542	♀	Near Mellen	Feb. 28	230	70	38	..	39.1	23.0
10543	♂	Near Mellen	Feb. 28	220	68	36	..	.....	22.1
10544	♂	Near Mellen	Feb. 28	220	67	38	..	38.5	23.2
10545	♂	Near Mellen	Mar. 1	230	70	38	..	40.1	23.4
10546	♂	Near Mellen	Feb. 28	220	77	38	7	38.3	22.4
10547	♀	Near Mellen	Feb. 28	219	78	39	7	38.6	22.6
10548	♀	Foot of The Needles	Mar. 5	230	86	38	8	38.5	22.4
10549	♀	Above Bill Williams River	Mar. 13	230	70	38	..	.....	22.5
10550	♀	Above Bill Williams River	Mar. 15	235	73	38	..	.....	22.8
10551	♀	Ehrenberg	Mar. 25	220	70	39	..	39.2	23.0
10552	♂	Ehrenberg	Mar. 26	223	75	40	..	39.5	22.8
10553	♀	Ehrenberg	Mar. 29	240	75	41	..	39.8	22.8
10554	♀	10 miles below Cibola	Apr. 8	225	72	38	..	39.8	23.4
10555	♂	10 miles below Cibola	Apr. 9	225	72	38	..	40.2	22.5
		Average of the 24 adults		227	73.4	38.7	6.9	39.3	22.7

[1] Not averaged, tail defective

The Needles, *harrisi* was observed as close as within one hundred yards of the water's edge. The animals did not, however, even here, show the least disposition to visit the water for any purpose whatever; so that the chances of being transported across to the opposite shore are practically nil. That in this part of the range of *harrisi* the Colorado River is the limiting barrier is a fact beyond question. There is a persistent statement in literature (for example, Elliot, 1905, p. 97) to the effect that *harrisi* occurs *in California;* but I am not cognizant of any basis for this assertion and I doubt its correctness.

Two races of *Ammospermophilus harrisi* have been distinguished within the state of Arizona. Mearns (1896, p. 444, and 1907, pp. 303–309) has characterized a form *A. h. saxicola* from extreme southwestern Arizona, thus restricting *harrisi* proper to central Arizona. I fail to find grounds, either in tone of coloration or relative length of tail, to warrant separate recognition of the Colorado River series from the animal of the vicinity of Tucson. Even Mearns' own tables of measurements do not bear out the size characters of his *saxicola*, which name might be expected to be usable for our specimens. The measurements of the Colorado Valley series are given herewith, as is also a table showing comparison with the near-related form *leucurus*, of the opposite side of the river (see pp. 220, 223).

Ammospermophilus leucurus leucurus (Merriam)

Antelope Ground Squirrel

Seventeen specimens obtained, all on the California side: 5 miles below Needles, 1; opposite The Needles, 5; Chemehuevis Valley, 2; Riverside Mountain, 1; opposite Cibola, 2; twenty miles above Picacho, 4; eight miles east of Picacho, 2. This rodent was not notably numerous anywhere, and was closely restricted to rocky or gravelly ground, chiefly among hills. It occupied the same ecologic niche on the California side that *harrisi* did on the Arizona side; and where the hills closely abutted upon the river, as at The Needles, the two species existed in places not more than three hundred yards apart, but with the river between. In no case was there any evidence of crossing; all individuals captured or seen were unquestionably one form or the other, and always appropriately segregated as regards the river.

No young of *leucurus* were taken; but a female taken five miles south of Needles, February 20, contained eight embryos, and another

taken at Chemehuevis Valley, March 11, contained five embryos. It is notable that the weather on the first date was very cold for the region. It seems to be a rule among the Sciuridae of the Colorado desert area that the young-of-the-year are well grown long before the period of intense summer heat.

Ammospermophilus l. leucurus and *A. h. harrisi* are perfectly distinct but closely related species. The following comparative table serves to show the differences between them, which differences must not be overemphasized as contrasted with the close general resemblances.

Ammospermophilus l. leucurus	Ammospermophilus h. harrisi
General size slightly less; body 149.4 mm.	General size greater; body 153.6 mm.
Tail relatively shorter, 44 per cent of body.	Tail relatively long, 48 per cent of body.
Audital bullae slightly smaller.	Audital bullae slightly higher, more inflated.
External ear slightly larger, 7.1 mm	External ear slightly smaller, 6.9 mm.
General coloration paler above, less brown more gray.	General coloration darker, distinctly brownish dorsally.
White side-stripes more conspicuous.	White side-stripes narrower and not so long.
Tail beneath pure white.	Tail beneath grizzled gray.
Tail carried appressed over the rump, displaying under surface conspicuously as if there were a white rump patch.	Tail carried vertically or inclined backward or forward, but showing no conspicuous white.
Tail often rapidly vibrated from side to side, causing the white to flicker	Tail often waved or jerked in fore-and-aft arc.

In the matter of audital bullae, *harrisi* parallels *Thomomys chrysonotus*, in the increased size of bullae on the Arizona side of the river. A curious anomaly appears in the reverse proportion in the size of the external ear in the two squirrels, *leucurus* of the California side having larger ears than *harrisi*. There are similar reverse ratios between ears and bullae in certain southern California *Perognathus*.

The most striking difference between *Ammospermophilus harrisi* and *A. leucurus* is, as noted in the table, in the color of the under surface of the tail and in the manner of carrying this appendage. It may be inferred that the musculature connected with the tail is quite differently developed in the two species, together, of course, with correlated nervous and circulatory differences.

The range of *harrisi* is practically restricted to Arizona and parts of Sonora. The range of *leucurus* and its geographic races almost completely surrounds that of *harrisi*. But, as far as I know, the ranges of the two nowhere overlap, nor has there been found any case of hybridization between the two. It is certain that only the existence of the Colorado River keeps the ranges of the two separate in this segment of their respective peripheries. What would have happened if the river had not served as an absolute barrier is, of course, wholly conjectural. But there is no doubt in my mind that in such event both the ranges and the characters of the two forms would be far different from what they now are.

LIST AND MEASUREMENTS IN MILLIMETERS OF *AMMOSPERMOPHILUS LEUCURUS LEUCURUS*, FROM THE CALIFORNIA SIDE OF THE COLORADO RIVER

Mus. no.	Sex	Locality	Date,	Total length	Tail vertebrae	Hind foot	Ear	Occipito-nasal length of skull	Zygomatic width
10556	♀	5 miles below Needles	Feb. 20	177[1]	40[1]	35.5	7	36.8	20.8
10557	♂	Opposite The Needles	Mar. 2	220	60	35	..	37.3	22.7
10558	♀	Opposite The Needles	Mar. 2	222	65	38	..	39.1	21.3
10559	♂	Opposite The Needles	Mar. 2	218	65	38	..	38.2	22.6
10560	♂	Opposite The Needles	Mar. 3	220	60	38	..	37.8	22.0
10561	♀	Opposite The Needles	Mar. 7	215	60	40	..	37.3	21.4
10562	♂	Chemehuevis Valley	Mar. 11	221	76	38	7	38.5	22.0
10563	♀	Riverside Mountain	Mar. 20	225	67	39	..	.....	23.2
10564	♀	Opposite Cibola	Apr. 4	235	75	38	..	.....	.....
10565	♀	Opposite Cibola	Apr. 5	190[1]	43[1]	40	9	39.0	22.3
10566	♀	20 miles above Picacho	Apr. 12	220	76	37	7	37.9	22.2
10567	♀	20 miles above Picacho	Apr. 13	220	67	37	..	39.2	.....
10568	♂	20 miles above Picacho	Apr. 13	215	60	38	..	40.0	23.1
10569	♀	20 miles above Picacho	Apr. 15	194	61	34	6	36.4	21.1
10570	♀	Chemehuevis Valley	Mar. 11	200	62	37	7	37.4	22.0
10571	♀	8 miles east of Picacho	Apr. 20	210	60	37	..	.....	22.2
10572	♂	8 miles east of Picacho	Apr. 21	220	70	39	..	38.0	22.2
		Average of the 17 adults		215	65.6	37.5	7.1	38.0	22.1

[1] Not averaged; tail defective.

Citellus tereticaudus tereticaudus (Baird)

Round-tailed Ground Squirrel

Fairly common at intervals from Needles to the Mexican line. Sixteen specimens were collected (nos. 10637–10651, 10722) on both sides of the river, as follows: California side: five miles below Needles 1, opposite Cibola 2, near Pilot Knob 4; Arizona side: at Mellen 5, five miles northeast of Laguna 3. The species was seen at no other places, and the inference is to be drawn that it is of quite interrupted distribution. This is explained when its associational position is taken account of.

Citellus tereticaudus is a sand-dwelling mammal, resembling in its preferences *Dipodomys deserti*, *Peromyscus eremicus* and *Perognathus penicillatus*. The squirrel, however, is even more restricted than either of these, for a rather large extent of arenaceous territory seems to be necessary to support a representation. Where the second bottom was broad, with accumulations of wind-drifted sand about the scattering *Atriplex* and creosote bushes, *tereticaudus* was best represented. Such a place was afforded on the Arizona side above Mellen. On the desert mesa similar conditions were rare, but where they did occur to any extent, as near Pilot Knob, the round-tailed ground squirrels were usually in evidence. The burrows open up among the stems of partly buried bushes, the animals foraging out over the bare intervals where seeds from annual plants are found sifted into the surface sand.

No young were seen by our party; but two females taken opposite Cibola, April 3 and 4, contained six and four embryos respectively. There are in the Museum two half-grown young (no. 7767, 7768) taken by Charles L. Camp at Needles, July 15 and 19, 1909.

The series of *Citellus tereticaudus*, when segregated into two groups according to the side of the river from which the individuals were obtained, shows appreciable diversity in external features. The specimens from the Arizona side are distinctly darker, more brownish than those from the opposite (California) side, even where obtained within but a very few miles of one another. This diversity in color is most marked at Needles, less so lower down the river. It would appear that the case is quite comparable to that in *Perognathus penicillatus*, where the darkest individuals hail from the east side of the river north of The Needles.

In measurements of the two groups, the Arizona-side examples of *tereticaudus* are shorter-tailed, as shown in the following comparison. Average of eight adults from the Arizona side as compared with average of seven adults from the California side (in parenthesis) is: total length, 234.1 (240.6); tail vertebrae, 76 (88.3); hind foot, 35.1 (35.5); ratio, tail to body, 48 per cent (58 per cent). These measurements of the California side examples are close to those of many others of the Colorado Desert west of the river. The shortness of tail is fairly well borne out in the measurements of *Citellus tereticaudus* from east of the river along the Mexican line as given by Mearns (1907, p. 338). The present series, however, is inadequate to settle the point satisfactorily.

It will be observed that in relative darkness of the Arizona side examples, we have here a parallel to the case in *Ammospermophilus*, while in ratio of tail to body the reverse relationships are presented. The degree of difference exhibited in *Citellus*, even if actual, is very slight as compared with the differences between *Ammospermophilus h. harrisi* and *A. l. leucurus*.

Castor canadensis frondator Mearns

Sonora Beaver

Signs of beavers were seen at many places along the river through the big valleys, from near Riverside Mountain to Pilot Knob. We heard of their occurrence also above Needles. At the present time, however, beavers are scarce along the Colorado River, this being said to be due to the unrelenting pursuit of them by professional trappers. Various evidences of the late presence of trappers were seen by us below Ehrenberg.

Very little of the beaver sign seen during our cruise of the river was fresh. The first noted was on the California side near the base of Riverside Mountain, March 16. Many young cottonwoods had been felled at the edge or within twelve feet of the main river channel, where its bank sloped steeply into deep water. The trees had been cut off about one foot above the ground and all felled down-stream, or, rather, diagonally, down-stream and towards the river. The largest cottonwood was fourteen inches in diameter where cut, the next two seven inches in diameter. Other cuttings were noted down to willow shoots one-half inch in diameter.

A stick "house" was located at the edge of the river a short distance below these cuttings. It resembled a mass of drift caught among the snags resulting from the undercutting of the timbered bank. This house was three and one-half feet in height, by fourteen and sixteen feet in two diameters on the ground. It consisted of small branches and broken saplings from the driftwood of the river and some brush dragged in from the land side. A little earth and dead leaves had been worked into the interstices. Less than a dozen beaver-cut sticks were in evidence in the whole structure. There were no fresh signs in or around this house. But a recently used "slide" was found on the bank a few yards off.

Opposite Riverside Mountain, and below Ehrenberg in at least two places, beaver cuttings were found on the Arizona side. And on the California side from near Ehrenberg to below Palo Verde considerable work was noted. In one place bark had been stripped within a day or two from a cottonwood sapling lying in the water, where it had recently fallen as a result of undermining by the river.

It was thought that the continual undercutting of its timbered banks by the river itself, thus precipitating many green trees into the water, provided an immediate food-supply for the beavers, so that even if present in numbers they would gain an easy living without themselves having to fell trees. It is possible, too, that the habitually unsettled behavior of the river accounts for the loss of the dam-building propensity, or at least for its futility on the part of the beavers of the Colorado Valley. We saw no signs anywhere of dams such as are reported by Mearns (1907, pp. 354–358) as occurring on the Verde River, Arizona, a tributary of the Gila, which in turn flows into the Colorado.

A used "house" located at the margin of a slough near Palo Verde was cut into by Stephens and Jones on April 3. It proved to be three feet in height and twelve feet across at the base. It consisted of branches and small saplings cut by the beavers when in full leaf, and laid compactly. The mass was eight inches thick over the nest cavity. The interior space was two and one-half feet high by four to five feet across. At one side the bank had been dug away to make the floor comparatively level, as the house was built on a sloping bank near its top. There was an under-water entrance at one side, and an opening through the wall above ground. A fresh willow sapling had been hauled through this opening butt first. The beds were merely hollows in the earth floor.

On both sides of the river in the vicinity of Pilot Knob there was considerable beaver sign, consisting of well-beaten trails up the banks, foot and tail prints, and cut willow saplings. At all points where prospects seemed at all favorable, traps were set, but our nearest approach to success was the securing of a front foot (no. 10731) in a trap on the Arizona shore opposite Pilot Knob. The shore sloped so gently at this place that the trap could not be set in water deep enough to insure drowning of the victim and yet occupy a position anywhere near the foot of the used slide. The animal had evidently pulled loose.

Further troubles in our efforts to trap beavers resulted from the continual rising or falling of the river and from the heavy deposit of silt. The latter so rapidly filled in the steel traps (Newhouse nos. 3 and 4), even when set upon broad strips of bark and staked out two feet or so from the actual bank, that beaver or any other animals could walk upon them without setting them off.

At the last trapping place, the lowering of the water repeatedly exposed both the traps and stakes, but tracks showed that during the night a beaver had gone past, nevertheless, indicating no particular shyness or suspicion.

From the reports given us by different people along the river, it is probable that beavers were abundant in suitable parts of its course up to a few years ago. As many as 250 skins are said to have been taken in a single year by one trapper. With observance of the protective laws now in force in both Arizona and California there is a chance for beavers to become sufficiently plentiful again to warrant a brief open season each year when the fur is prime. I see no reason why the Colorado River should not produce a regular output of skins, provided the number taken annually be adjusted to the rate of increase.

Peromyscus maniculatus sonoriensis (Le Conte)

Sonora White-footed Mouse

An abundant inhabitant of the bottomlands everywhere, this in spite of the annual overflow which might be expected to drown out a mammal of this non-aquatic genus.

The 65 specimens secured (nos. 10100–10164) represent the following localities: California side: five miles below Needles, opposite The Needles, Chemehuevis Valley, at Riverside Mountain, above Ehrenberg, near Palo Verde, eight miles below Picacho, four miles south of

Potholes, five miles northeast of Yuma, and near Pilot Knob; Arizona side: Mellen, Ehrenberg, twenty-five miles below Ehrenberg, five miles northeast of Laguna, near Yuma.

The species thus proved to be regularly distributed all along the Colorado Valley. Yet we failed to trap it anywhere on the nearby desert outside of the mesquite belt. In other words, this *Peromyscus* has appropriated the river bottom, which, in turn, is tabooed by the two desert species of the region, *eremicus* and *stephensi*. It is to be inferred that *sonoriensis* used the Colorado Valley as a highway of immigration through the region, and found it suitable for permanent occupancy. The *maniculatus* division of the genus *Peromyscus* is notorious for its success as an invader. Single subspecies representative of this group range through the habitats of dozens of other species of small rodents, from the hottest, Lower Sonoran, Colorado desert to the Boreal zone on the San Bernardino Mountains. It is thus a remarkably hardy animal; yet, as far as known, it nowhere thrives to the *total exclusion* of other small rodents, save in the case of slightly different subspecies on certain islands.

The aggressiveness of *Peromyscus m. sonoriensis* was illustrated by our experience along the Colorado. It was the only wild mammal which found its way on to our boats; individuals were twice routed out of the cargo of supplies on the scow. This boat was most of the time moored alongside the shore, either touching the bank at one corner, or with a gangplank out, so that any venturesome animal could easily go aboard.

At a point five miles northeast of Yuma, Sonora white-footed mice were trapped April 30 on a river bar covered with a very young growth of willow. This was at a time when the rising water had already cut the place off from connection with the main shore. Footprints of mice were plentiful on the dry, fine silt on the higher part of the island thus formed. In several other places this rodent was trapped on portions of the flood-bottom elevated in such a degree that they would have been first cut off from the shore as the water rose and then set adrift. In some of these cases safety could have been secured by swimming short distances through relatively quiet water, or by taking refuge on floating drift. It is highly probable that in the rush of flood waters a large mortality must annually occur.

It is probable also that the paucity of snakes and other enemies in the flood-bottom gives this mouse relative immunity from those dangers which beset the small mammals out on the desert; so that

sonoriensis can stand the fatalities due to the river's irregular habits and still maintain a large population, without any modification in birth rate.

Mice of the *Peromyscus maniculatus* group are known to be much more prolific than *Perognathus* or *Dipodomys*, not so much because of the larger litters but because there are several litters each year in the first-named rodent, and only one as a rule in the last two. On the Colorado the results of our collecting give but little information as to the breeding of *P. m. sonoriensis*. A female taken March 25 contained five embryos; one taken May 5 contained three embryos.

Peromyscus crinitus stephensi Mearns

Stephens Cañon Mouse

As judged from the results of our three months' trapping, this was the least numerous of the smaller rodents of the region. Only thirteen specimens were procured, apportioned by locality as follows: Opposite The Needles, five (nos. 9978–9982); above Ehrenberg, one (no. 9983); twenty miles above Picacho, two (nos. 9984, 9985); Potholes, two (nos. 9986, 9987); Pilot Knob, three (nos. 9988–9990).

All of these localities are on the California side of the river. It would thus appear that in its lower course the river forms an absolute barrier to the eastward spread of this mouse. Yet it has been taken on the Arizona side of the Colorado, whence, considerably above Fort Mohave, Osgood (1909, p. 233) has recorded three specimens.

The associational preferences of this mouse are most pronounced. All of the specimens were captured near or among rocks in ravines or on steep hillsides. It is thus a rupicoline species with much the same associational exclusiveness as *Perognathus spinatus*. As in the case of the latter, each mountain mass probably possesses its more or less completely isolated colony of these mice, separated from its neighboring colony by the uninhabited interval of level mesa or valley.

Peromyscus eremicus eremicus (Baird)

Desert White-footed Mouse

The series of 109 specimens of this mouse (nos. 9991–10099) are representative of the following localities: Arizona side: Mellen, foot of The Needles, above Bill Williams River, Ehrenberg, twenty-five miles below Ehrenberg, ten miles below Cibola, five miles north of Laguna, and Yuma; California side: opposite The Needles, Chemehuevis Valley,

Riverside Mountain, Palo Verde, opposite Cibola, twenty miles above Picacho, eight miles below Picacho, Potholes, five miles above Yuma, and Pilot Knob.

The wide occurrence of *Peromyscus eremicus* through the region is thus indicated. Yet our trapping showed distinct associational preferences. The overflow bottom is evidently rarely invaded, there being but slight overlapping of the habitat of *Peromyscus maniculatus sonoriensis;* and the rocky hills and mesas are eschewed, so that in this direction the domain of *Peromyscus crinitus stephensi* is seldom encroached upon. *P. eremicus* was found in greatest numbers on arenaceous alluvium *not* included in the overflow area of the river bottom. It was present on the second bottom outside the mesquite belt, and along desert washes leading down from the interior; also on the desert mesa where wind-blown accumulations of fine sand afforded the same sort of ground, that is, ground of a fine but loose consistency, easy to burrow into.

The breeding season of the desert white-footed mouse, as indicated by the following dates, covers at least three months. Nearly or quite full-grown, blue-pelaged young were taken as early as March 2, and from then on at increasingly frequent intervals until the last of April. Females were taken March 5 with three embryos, March 8 with three embryos, April 13 with four embryos and April 19 with four embryos.

Sigmodon hispidus eremicus Mearns

Western Desert Cotton Rat

This rodent proved to be strictly riparian in its associational preferences, and, furthermore, was found only along the lower course of the river, below Ehrenberg. It belongs to a southern zone, tropical or semi-tropical, and is one of the lowest zonal elements entering the region; moreover, it has not pressed its way far up the river.

I should judge its habits and food requirements to be closely similar to those of *Microtus*, of cooler regions. But as far as known, the ranges of *Sigmodon* and *Microtus* do not quite meet anywhere. Certainly there are no *Microtus* in the Colorado River bottom as low down as Needles. *Sigmodon* thus has a clear right of way, from a competitive standpoint.

The three localities of capture are all on the California side; yet there is every reason to suppose that cotton rats occur on the Arizona side as well, being surely as readily able to swim as harvest mice.

In the bottomlands a few miles below Palo Verde, cotton rats were found in apparent abundance March 31 to April 3. They were here inhabiting a tule patch at the edge of a slough and a dense patch of seedling willows adjacent. There were no runways in evidence, but a dozen or more little piles of cut willow twigs were found lying on the ground one to four feet from the edge of the water.

The twigs were from four to eight inches in length with teeth-cuts at each end, and there were from half a dozen to twenty of these twigs in a pile. A few bits of tule stems were found in one place, and in another a rather thick green tule stem was nearly eaten through. The stomach of one of the rats taken contained a finely masticated mass of material judged to be tule stem.

Five miles northeast of Yuma, *Sigmodon* was found April 30 to May 3 inhabiting a tract of wire-grass bordering a back-water slough near the river, and flanked by young willow growth. Near Pilot Knob, May 10, specimens were caught in thickets of cane surrounded by dense arrowweed.

A half-grown young one was caught on the last named date. A gravid female was caught on April 30.

The weight of one of the largest males taken (no. 10626) was eight ounces; that of a smaller male (no. 10632), though quite adult, 4½ ounces. A very great range in size is also shown from the accompanying table of measurements, which lists all of the specimens taken by the expedition. So great is the discrepancy between nos. 10626 and 10627, and other apparently fully adult males in our series, that the existence of two distinct species was at first suspected. The two large examples referred to present measurements far above any of the specimens listed by Mearns (1907, p. 453), and some twenty per cent above the typical size of the race *eremicus* as given by Bailey (1902, p. 107). There are also apparent other differences concurrent with the great size, namely, rather coarser pelage, greater hairiness of tail, and a faintly pinkish cast to the coloration on the rump and sides.

I sent specimens illustrating this state of affairs to Mr. Vernon Bailey, who gives it as his opinion that the differences are due to age; in this genus "old males often outgrow the bounds of specific characters." In support of this contention, that the extremes are conspecific, is the consideration of geographical probabilities: to-wit, that experience teaches that it is not to be expected that two closely related species in a genus exist together in exactly the same locality.

LIST AND MEASUREMENTS IN MILLIMETERS OF *SIGMODON HISPIDUS EREMICUS* FROM THE CALIFORNIA SIDE OF THE LOWER COLORADO RIVER

Mus. no.	Sex Age	Locality	Date	Length	Tail	Hind foot	Ear	Body with head	Basilar length of Hensel	Greatest length of nasals	Zygomatic breadth	Mastoid breadth	Alveolar length of upper molar series
10626	♂ ad.	Palo Verde	Mar. 31	327	146	33	22	181	.....	15.3	.....	16.0	6.7
10627	♂ ad.	Palo Verde	Apr. 3	335	138	36	22	197	33.4	16.0	23.4	16.8	7.0
10628	♂ ad.	Palo Verde	Apr. 3	211+	56+	34	20	155	28.2	13.8	20.9	14.3	6.7
10629	♀ ad.	5 mi. N.E. Yuma	Apr. 30	252	122	31	18	130	26.7	13.0	18.9	.....	6.2
10630	♂ ad.	5 mi. N.E. Yuma	Apr. 30	243	106	31	17	137	.....	12.1	.....	.....	6.3
10631	♀ ad.	5 mi. N.E. Yuma	Apr. 30	246	106	30	17	140	25.8	12.8	19.5	13.5	6.1
10632	♂ ad.	5 mi. N.E. Yuma	May 1	291	130	34	18	161	29.8	14.1	20.7	14.5	6.2
10633	♂ ad.	5 mi. N.E. Yuma	May 2	246	128	32	17	118	.....	13.3	.....	.....	6.4
10634	♀ ad.	5 mi. N.E. Yuma	May 3	280	131	32	20	149	27.7	13.2	19.6	13.7	6.5
10635	♂ ad.	Pilot Knob	May 10	202+	60+	31	17	142	27.6	13.5	19.6	13.8	6.5
10636	♂ juv.	Pilot Knob	May 10	190	91	28	15	99	.....	.....	.....	.....	....
10715	♂ ad.	Pilot Knob	May 10	290	135	33	18	155	29.5	13.6	20.4	14.7	6.4

On the other hand, these aberrant examples might be recognized as mutants, that is, variants of phylogenetic significance though not geographically isolated. After going over the ground, I lean personally towards the notion of the existence of an exceptionally wide range in ordinary fluctuational variation, as accounting for the extremes in question. This is coupled with the inadequacy of the material available, so that the distinctions are emphasized. With large series more nearly normal frequency would be expected.

In this connection it may be pointed out that an alleged race, *Sigmodon hispidus arizonae* Mearns (see Bailey, 1902, p. 108), has been described from Fort Verde, Yavapai County, Arizona, with characters close to those appertaining to the Colorado River giants in question. In size these two specimens from the Colorado equal or exceed that of the type of *arizonae*, so that the existence of a separate race based on size is questionable.

Reithrodontomys megalotis deserti J. A. Allen

Desert Harvest Mouse

This rodent was confined strictly to the riparian strips. Although not found by us above Ehrenberg, it probably does occur in suitable environs as far up the Colorado as these are afforded, that is, up to the steep-walled cañons above Fort Mohave. Specimens were trapped close to the water's edge, usually in grassy places adjacent to tracts of willows. In some cases these mice were on islands cut off by channels from connection with the shore. In practically all cases the ground they occupied would at high water be entirely submerged, so that the mice would either have to swim to higher ground or take refuge in the willows and drift piles. Doubtless they swim freely and are also swept back and forth across the river channels at flood time.

Twenty-one specimens were preserved (nos. 10165–10185). The localities of capture were: Arizona side: Ehrenberg, five miles north of Laguna, and Yuma; California side: near Palo Verde, and five miles northeast of Yuma. Young over half grown were taken May 2, and on the same day a female containing five embryos.

Neotoma albigula venusta True

Colorado Valley Wood Rat

This species of wood-rat was in distribution the exact associational complement of *Neotoma intermedia desertorum*: it was restricted to

the riparian strips, and no evidence was forthcoming of its occurrence out on the desert mesa, in the hills, or even up the desert washes. As compared with rodents of the desert proper this species might for the sake of emphasis be termed semi-aquatic, for it was trapped within a few feet of the main river, and its tracks were noted on fresh mud at the water's edge. Individuals were caught on willow-grown islands, which were subject to submergence with rising water, so that the animals would be forced to live in trees or take to water. No signs of nests were observed in trees anywhere, and it seems reasonable to suppose that these wood rats voluntarily swim narrow channels, especially when pressed by hunger.

Although foraging widely over the bottomlands, the permanent abodes of these rats appeared to be chiefly located at the lateral rims of the riparian belts, just at the upper reach of high water. This, too, marked the belt of mesquites, so that the mesquite association can be confidently assigned as the distinctive habitat of *Neotoma a. venusta*.

At no point did we find the "enormous nests" of this species described by Mearns (1907, p. 474) as found by him below Yuma. His name, *Neotoma cumulator*, for this species was selected on this account. A few small stick houses were found by us in the mesquite strip above Mellen, and nests of similar scant proportions, at other places down the river. In all cases the rats appeared to have ready access to subterranean burrows. At the mouth of the Gila River, near Yuma, many burrows were found in a tract of guatemote without trace of stick nests, and a number of the animals were caught. It is quite possible that recurring unusually high flooding discourages the rats in the portion of their range explored by us from amassing much material, since it is subject to being floated off.

We found small young as early as February 24 and 25 at Mellen, and from that date on to May 5, near Yuma. It is probable that the breeding season is just about closed by the time the annual overflow begins, so that young as well as adults are able to seek safety for the brief period of exile by assuming arboreal habits or swimming to higher ground.

The series of 68 specimens of *Neotoma albigula venusta* obtained (nos. 10463–10530) represent localities of capture as follows: California side: near Riverside Mountain, 2; Palo Verde, 2; twenty miles above Picacho, 8; eight miles below Picacho, 2; five miles northeast of Yuma, 8; Pilot Knob, 3. Arizona side: Mellen, 12; Ehrenberg, 3; twenty-five miles below Ehrenberg, 1; ten miles below Cibola, 7; five

miles northeast Laguna, 6; near Yuma, 14. Two adult males from twenty miles above Picacho and near Yuma weighed nine ounces each; an adult female from the former station weighed seven ounces.

No differences are observable between the specimens from the two sides of the river. The river is evidently in scarcely any degree a barrier to distribution in this species. Rather has the Colorado bottom served as a highway of invasion for the species from its center of distribution, which is manifestly to the southward, the desert on either side acting as confining walls. An examination of the series of specimens shows an apparent slight decrease in size up the river, that is, away from the assumed center of dispersal. But since there is also continued, though diminished, growth of individuals with age, and because of the few examples from any one of the uppermost stations, this direction in variation up the river is not to be considered as established. Much more material is needed.

Neotoma intermedia desertorum Merriam

Desert Wood Rat

The 41 specimens taken (nos. 10424–10462, 10716, 10717) indicate stations of occurrence as follows: California side: opposite The Needles, 3 specimens; Riverside Mountain, 2; opposite Cibola, 1; twenty miles above Picacho, 13; eight miles below Picacho, 3; Potholes, 2; Pilot Knob, 11. Arizona side: foot of The Needles, 3; above Bill Williams River, 1; ten miles below Cibola, 2.

None of our specimens was trapped within the riparian strips; all were taken on the desert proper, though at The Needles, where because of the abrupt rock walls the riparian element is in places reduced to a mere nearly vertical band, desert wood-rats or signs of them were found within a few yards of the river on the opposite sides.

Here scanty accumulations of sticks were observed in crevices among loose boulders on hillsides or in clefts of the walls of ravines. At Riverside Mountain, some two miles back from the bottomlands, nests of large size were noted among boulders; this was true, too, at Pilot Knob, where also sign was seen and the rats themselves caught around clumps of desert tea far out on the mesa.

Fifteen of the specimens taken at the different stations are young of varying sizes. Two very small young of 172 and 167 mm. length, respectively, were trapped March 6 and 7 at The Needles, indicating early breeding. Others nearly as small were taken at Pilot Knob, May

10; so that there is not such constancy in breeding time in this species as in certain other rodents of the region.

A careful comparison of the six specimens secured from the Arizona side with the much larger series from the California side, shows both cranially and as regards external features, no tangible differences which might be expected to occur (and do occur in other cases) in a mammal of the desert proper and whose range is divided by the Colorado River.

It appears that this species of wood-rat has not previously been found to the east of the Colorado River (see Goldman, 1910, pp. 76, 77). In fact, in his revision of the genus *Neotoma*, Goldman, in discussion of *Neotoma lepida* and its subspecies *stephensi* (which are forms not dissimilar to *desertorum*), states (1910, p. 80) that "the ranges of the two [*lepida* and *desertorum*] are completely separated by the effective barrier of the Colorado River." While the results of our work detract from this statement as to fact, the implication remains the same, namely, that the Colorado River may have been at one time of prime service in effecting the isolation of the *lepida* stock, particularly in the upper (northeastern) course of the river (see Goldman's map, p. 77).

I sent my Arizona-side examples of *desertorum* to Mr. Goldman with the request that he examine them closely and give his opinion as to their possible approach in characters to *N. l. stephensi*. The latter form is, by the way, the nearest wood-rat of the same group recorded from east of the river, its nearest station being (Goldman, 1910, p. 80) the Hualpai Mountains, Arizona, only about fifty miles east of The Needles. Mr. Goldman replied that my specimens were "typical *desertorum*," and hence not bearing any significant resemblance to *stephensi*.

It would appear, therefore, that the *desertorum*, as found by us on the Arizona side of the Colorado at the three stations named, is of probably direct and relatively recent descent from the stock on the California side. While this wood-rat does not inhabit the river bottomlands, as does *Neotoma a. venusta*, it is quite possible that individuals forage down to the water's edge where the riparian strip is reduced in width or practically wanting, as at The Needles. In event of rats becoming marooned on drift-rafts at periods of rising water such animals would be in a position to be ferried across the river; for it is not unlikely that such rafts would be carried by the swerving currents to opposite banks. No matter where such waifs should be landed they

would, ultimately, barring accidents, tend to reach the same sort of environs they were used to, namely, the rocky hill slopes.

While such a series of propitious events is in but a remote degree possible, it appears to me the most logical way of explaining the extension of the range of *desertorum* across the Colorado to the Arizona side. As above intimated, this occurrence, if a fact, does not militate against Goldman's hypothesis that *lepida* and *desertorum* may have been held apart by the Colorado River, and are still so held apart in most of its course.

Ondatra zibethica pallida (Mearns)

Pallid Muskrat

Evidence, hearsay and direct, indicates the presence of muskrats all along the Colorado River, from above Needles to below the Mexican line. They occur both in the main stream and in the various diverging sloughs of the big valleys. Our nine specimens (nos. 10652–10660) were all secured on the California side of the main stream, three near Palo Verde and six near Pilot Knob.

No signs of houses were seen anywhere, the muskrats appearing to resort entirely to holes in banks where the current was sluggish. Near Palo Verde, April 1, a system of burrows was dug out by Stephens and Jones. This system of holes was in the bank of a tule-bordered slough about a half mile above its confluence with the main river. The entrances all opened considerably beneath the surface of the water at its level at the time. From these the burrows sloped upwards as they extended back from the slough, until those parts farthest from the water were two to three feet above its level at that stage.

Some green tule stems were found in the passage-ways. One of the blind leads was filled in with packed tule stems, mostly dead ones, but moist and crushed. The regular nests consisted of dry tule stems, some of them shredded, and laid two to three inches deep. Some of the short blind leads showed fresh claw scratches in the earth at their ends. The passage-ways were ordinarily five inches in diameter, in places more, and usually kept near the surface of the ground, following its irregularities pretty closely. In places there was not more than three inches of earth above the burrow, and there was seldom as much as a foot. The system was in fact discovered by one of the party's stepping upon a thin place and breaking through.

The impression gained from a survey of the uncovered burrows was that the excavator had at the beginning burrowed up from the

slough five to eight feet, then gone back a third of the way and started a branch to the water for another entrance. After finishing that, it had come half way back on the branch and dug another branch from it inland, then a branch from that to the water again. Roughly speaking, a series of connected Y's thus resulted, with ends alternately in the water and in the bank landwards. It would appear as though such a plan of runways were well adapted to eluding enemies, both terrestrial and aquatic. An adult male and two two-thirds-grown young were trapped in the entrance burrows.

In the vicinity of Pilot Knob the muskrats were living along the steep northern bank of the main river, where the water was overhung by a dense growth of cane. A number of willow branches sagging into the water and drift logs caught in the tangle of cane (pl. 4, fig. 3) showed themselves to be the nightly rendezvous of muskrats. On these, at the farthest projecting portions, and usually not over four inches above the surface of the water, capsule-shaped pellets of excrement to the number of three to a dozen or more marked the perching places of the rats. This excrement was usually fresh, as the logs would go awash with the frequent cross-river winds. Number 0 steel traps set on these logs without attempt at concealment, either with or without bait (apple or potato), caught five adult muskrats, May 10 to 14. Four out of the five were drowned, the traps being provided with chains which in turn were nailed to the logs. A half-grown youngster was shot on the latter date as it swam among some trailing cane stalks.

Muskrats have recently invaded the Imperial Valley along the irrigation canals leading from the Colorado River. I visited this valley in February, 1912, and was told there that the California Development Company found it necessary to hire men to shoot and trap muskrats because of the damage done in burrowing through the levees. The rats even follow the smaller ditches out into the farms at Calexico, Heber, and El Centro. At Calexico, February 8, I obtained a fresh specimen shot by a boy on a farm close by, on the California side of the Mexican boundary.

The entire series of ten specimens of the pallid muskrat in the Museum displays the now well-known features peculiar to the race represented, namely, small size, pale color and relatively scanty pelage (see Mearns, 1907, p. 495). The weights of the five full-grown male animals were: 31, 24, 21, 26, and 27 ounces, respectively; average 26 ounces.

Thomomys chrysonotus Grinnell

Ehrenberg Pocket Gopher

The only place on the Arizona side of the river where gopher sign was seen was on the mesa within two miles back from Ehrenberg. Here two sets of mounds were found on low sandy ridges and a single gopher caught from a burrow, March 27. This specimen is a male, young adult (no. 10617) and proved so different from any previously described race of gopher as to warrant making it the basis of a new specific name (see Grinnell, 1912, p. 174). This is evidently an upland species, that is, not riparian, and its nearest relationships are suggested to be with forms to the east and north rather than with *T. perpallidus* or *T. albatus* of the desert region west of the river.

Thomomys albatus Grinnell

Imperial Valley Pocket Gopher

At only one station on the California side of the river did we find any sign of gophers. This was at our last camp, east of Pilot Knob, where on the site of the old Hanlon Ranch several sets of workings were located, and eight specimens taken (nos. 10618–10625), May 7 to 10. Four of the animals were young, not more than half grown.

These workings were all on the first bottom just at the outer margin of the arrowweed association, in ground barely reached at the highest level of overflow. The absence of gophers in the greater portion of the Colorado bottom is reasonably explained by the occurrence of the yearly overflow which would drown them out. The colonies invading the river bottom do so only at points which they reach from some more favorable center of distribution back from the river.

As already shown (Grinnell, 1912, p. 172), our gophers from the Pilot Knob station belong to the species occupying the alluvial delta region including Imperial Valley, which species is distinct from both the one represented on the Arizona side at Ehrenberg (*Thomomys chrysonotus*) and the one of the western end of the Colorado desert, at Palm Springs (*Thomomys perpallidus*).

The characters distinguishing *albatus* from *chrysonotus* cannot be reasonably considered as due alone to the action of the river as a barrier, for the former species belongs to a different association (saltbush) from the latter which, as far as known, adheres to the

creosote association. Thus the two species *might* exist on the same side of the river, with complementary ranges. Still, as far as known, neither species occurs on the opposite side of the river, the river thus serving as the factor of absolute delimitation in the respective cases. It is probable that the two species had latterly a separate course of origin, having been derived from distantly located stocks.

Dipodomys deserti deserti Stephens

Big Desert Kangaroo Rat

The thirty-nine specimens secured were preserved as follows: nos. 10352–10381, skins with skulls; nos. 10708, 10709, complete skeletons; nos. 10724–10730, alcoholics. The following localities are represented: Arizona side: Mellen, 23; Ehrenberg, 2; twenty-five miles below Ehrenberg, 1; five miles northeast of Laguna, 3. California side: Riverside Mountain, 1; near Pilot Knob, 9.

This rat shows strong preferences for the aeolian sand association. It was found present practically wherever such accumulations reached an extent of an acre or more of sufficient depth to contain the burrows. This essential depth was seen to be at least a foot. Because of the limited powers of digging, as shown both by weak incisors and small front feet and claws, only such loose and fine-grained substratum could be occupied by this rodent. The packed floor of the mesa or the hardpan of the hillsides was uninhabitable.

The presence of this *Dipodomys* could always readily be recognized by means of conspicuous burrows, the mouths of which were usually at all times open. The looseness of the ground in which the burrows are dug results in their frequent caving in when men or horses walk over them. When the wind had not acted to efface them, the tracks of the rats could be plainly seen on the surrounding sand surface (pl. 11, figs. 16, 17). These tracks showed imprints of the hind feet and tails, indicating the tripedal mode of ambulation characterizing the Heteromyidae.

The associational restriction of this large kangaroo rat gives the impression that it possesses a colonial habit. But it was observed that where proper conditions were continuous, as at the north base of Pilot Knob, the local distribution over the suitable area was practically uninterrupted. The burrows occur in small groups, each group probably representing but a single home center and occupied at times by a single adult, at others by an adult pair, and at others by adult and

young. Tracks were to be seen far and wide between the scattering groups of burrows.

At Mellen, February 25, specimens of *Dipodomys deserti* trapped had their cheek-pouches filled with the minute blossoms and stem ends of *Achyronychia cooperi,* an inconspicuous plant growing prostrate upon the surface of the broad, sandy intervals between the creosote and *Atriplex polycarpa* bushes (pl. 11, fig. 16).

The series of specimens from Mellen, on the Arizona side at the north, is faintly darker in color dorsally on an average than the series from near Pilot Knob on the California side at the south. Otherwise I can see no differences between specimens from the two sides of the river.

Like *Peromyscus eremicus* and *Perognathus penicillatus, Dipodomys deserti* inhabits the second bottom in places along the river, though much less continuously than these smaller rodents. Doubtless, as with them, individuals occasionally forage on to the first bottom, and thus run the chance of being transferred from one side of the river to the other by means suggested in other parts of this paper.

Dipodomys merriami merriami Mearns

Merriam Kangaroo Rat

A series of 168 specimens of this small kangaroo rat were preserved, and besides these many were disearded. The Museum numbers are: 10186–10351 (skins with skulls), 10710–10712 (skeletons), 10733–10741 (alcoholies). The following localities are represented: Arizona side: Mellen, 18; foot of The Needles, 6; above Bill Williams River, 6; Ehrenberg, 10; twenty-five miles below Ehrenberg, 3; ten miles below Cibola, 8; five miles northeast of Laguna, 12; Yuma, 2. California side: five miles below Needles, 3; opposite The Needles, 4; Chemehuevis Valley, 10; near Riverside Mountain, 6; above Blythe, 3; opposite Cibola, 19; twenty miles north of Picacho, 21; eight miles below Picacho, 12; Potholes, 5; Pilot Knob, 20.

As indicated above, this was a widespread and abundant desert rodent, being taken in nearly every line of traps outside of the overflow bottom. Its greatest abundance occurred on sandy ground adjacent to desert washes, on tracts of aeolian sands on the desert mesa, and on the second bottom paralleling the river on either side through the broad valleys, but wholly above the reach of the highest floods. In a number of cases specimens were trapped on the packed

ground of the upper mesa, and occasionally on rocky hillsides. These instances probably show great extent in foraging radius, the home burrows being in the softer ground of neighboring ravine bottoms or in depressions where sand could lodge. For, as far as observed, the burrows are always dug by the animals themselves, and their burrowing powers are weak.

Their small size, however, does not require anywhere near the depth of workable soil that the huge *D. deserti* needs. Probably the far greater restriction in distribution of the latter species compared with that of *D. merriami* is determined by this difference in depth of soil required.

The burrows of *D. merriami* are not easy to locate, as the entrances are left smoothly closed during the day. But where the fine wind-laid sand composed the surface of the ground, the hind foot and tail tracks showed clearly the routes taken by the rats to and from their burrows.

The breeding season is at its height in April, though the following dates show considerable latitude. Females with embryos were taken on February 19, March 5 and 6, April 1 to 4, 19 and 21, and May 8. On each of the above dates but one animal is concerned, except during the period from April 1 to 4, when observations were made upon at least ten, and April 19, upon two. In sixteen cases there were two foetuses, in two cases three.

The above data indicate a relatively slow rate of reproduction: but one litter per year is raised and there are seldom more than two young to a litter. This indicates a much safer existence, individually, for this kangaroo rat than for the ground squirrels and white-footed mice of the same habitat. In the case of these latter rodents litters consist of four to eight young, and in some species, at least, two or more litters are born each year. Kangaroo rats must be relatively very successful in escaping the numerous enemies that assail the rodent population of the desert.

The writer finds it impossible to refer the Colorado River series of *Dipodomys merriami*, as a whole, to the subspecies *D. m. simiolus* (type locality, Palm Springs, on the western arm of the Colorado Desert), as might have been expected. The material shows great range in variation; some of the specimens, particularly in the series from the lower course of the river, are, it is true, very close to *simiolus*. On the other hand many, especially from the Arizona side of the river above Ehrenberg, are not with certainty distinguishable from near-topotypes of *D. m. merriami*, from south-central Arizona. It proves,

however, impossible to assort the series into two subspecies on any satisfactory basis, and, since the average appears nearest *D. m. merriami*, all are placed under this name.

Perognathus bombycinus Osgood

Yuma Pocket Mouse

Twenty-five specimens were procured (nos. 9956–9977, 10742–10744), three being preserved as alcoholics, and the rest as skins-with-skulls. Only two localities are represented, near Ehrenberg on the Arizona side of the river, where eighteen specimens were caught March 25 to 30, and near Pilot Knob on the California side of the river, where seven were taken May 7 to 15. Those at Ehrenberg were caught on areas of wind-blown sand, especially where heaped about the bases of creosote bushes, on the mesa a mile or more back from the river. At Pilot Knob the species was found on aeolian sand accumulations and in shallow sandy washes on the desert mesa.

In all cases *Perognathus bombycinus* was found on common ground with *Dipodomys deserti*, *Dipodomys merriami*, *Peromyscus eremicus*, and *Perognathus penicillatus*. The five rodents named thus have very similar associational preferences. While *Perognathus bombycinus* was not found by us as near the river as the second bottom (as were all the other rodents named) it is fair to assume that it may so occur where conditions favor. And like the others of the same association, transfer of individuals from side to side is likely to have taken place at intervals in the past. This might be advanced as a reason for the close similarity of the representations of *bombycinus* on the two sides of the river.

The original description of *Perognathus bombycinus* (Osgood, 1907, pp. 19, 20) was based on a single specimen from Yuma, Arizona, and two from just over the Mexican line in Sonora. Our present series bears out to the dot the cranial characters assigned by Osgood, namely, as compared with *Perognathus panamintinus bangsi*, enormously inflated audital bullae and mastoids, the latter conspicuously protuberant posteriorly, and narrow interparietal. Externally our specimens of *bombycinus* are distinguishable from *bangsi* in their very pale coloration, which consists in lighter ground color (dilute pinkish buff) and almost obsolete black tippings to the hairs dorsally. Although, as compared with *bangsi*, *bombycinus* has greatly enlarged audital bullae, the external ear is not of appreciably greater size.

The measurements of twenty adult males from our series are, averages and extremes: total length 139 mm. (130–149), tail vertebrae 79 (70–85), hind foot 18.5 (17–19.5).

I am unable to find any differences between the specimens from Ehrenberg and those from Pilot Knob, the species being thus identical on the two sides of the river. We found no traces of pocket mice of this group anywhere else along the river. Osgood (1907, p. 20), however, records typical *bangsi* from Needles, California. It is quite possible that there is a hiatus between the ranges of *bangsi* and *bombycinus*. At any rate, among the large series of *bangsi* in the Museum from the Mohave desert and from the west side of the Colorado desert from San Gorgonio Pass to the Mexican line, there is no individual showing close enough approach in characters to *bombycinus* to warrant classing it as an intermediate. Although the affinities of *bombycinus* are clearly with the *panamintinus* group, there is good evidence for carrying the former as a full species.

Curiously, only one out of the entire twenty-five *bombycinus* taken was a female. This, and the fact that no young-of-the-year were found, would seem to show that up to May 15 the breeding season had not yet begun. For experience with other rodents in different places indicates that as soon as the young are born the females forage abroad actively, and are then caught in at least equal proportions to the males.

Perognathus formosus Merriam

Long-tailed Pocket Mouse

A series of 44 specimens was obtained, 40 skins-with-skulls (nos. 9652–9691) and 4 alcoholics (nos. 10794–10797). These were taken exclusively on the California side of the river and represent localities as follows: five miles below Needles, 6; opposite The Needles, 12; Chemehuevis Valley, 8; Riverside Mountain, 5; near Blythe, 1; Potholes, 5; Pilot Knob, 7.

The known range of this species is thus carried southeast along the west side of the Colorado River to the Mexican line (see Osgood, 1900, pp. 40, 41). The distribution is not, however, continuous, for marked restriction is shown to hilly country and rough mesas. The immediate valley of the Colorado is avoided, as also the broad, flat and low desert depressions between the mountain ranges.

Yet within the rough country trapping showed that *Perognathus formosus* occurred most frequently upon the narrow strips of loose,

sandy soil along ravine bottoms or along washes cutting the elevated mesas. This closer associational phase of occurrence is significant on comparison with the local distribution of *Perognathus spinatus*. *Formosus* and *spinatus* both live west of the river, and both occupy the same general associations (see figs. C, F). But locally the two are often found on separate ground, *spinatus* adhering most closely to the vicinity of boulder-strewn hillsides and fractured outcrops, while *formosus* prefers smoother ground, as noted above.

At Riverside Mountain *formosus* was caught on the mesa, but not next to the abruptly rising base of the mountain where *spinatus* was found. But opposite Cibola, where pocket mice were phenomenally abundant, examples of *Perognathus spinatus*, *P. formosus* and *P. penicillatus* were all caught within a radius of fifty feet. The first two species were found in a single trap on successive mornings.

As further considerations with regard to the occurrence of *formosus* and *spinatus* on common ground, it is to be remembered that the two species belong to separate subgenera (*Perognathus* and *Chaetodipus*, respectively), and thus have structures so different that important differences in food or other requirements are suggested; so that the forms are probably complementary instead of violently competitive.

The breeding time of *Perognathus formosus* is indicated by the capture of blue-pelaged young at Potholes and Pilot Knob on April 28 and 29, and May 10 to 14. Preceding the first-named date no signs of breeding were in evidence, so that relative lateness in this annual function is indicated.

Perognathus penicillatus penicillatus Woodhouse

Colorado Desert Pocket Mouse

A series of 196 specimens preserved, 184 as skins-with-skulls (nos. 9692–9875), two as skeletons (nos. 10720, 10721), and ten as alcoholics (nos. 10798–10807). The following localities are represented: California side: five miles below Needles, 8; opposite The Needles, 10; Chemehuevis Valley, 17; near Riverside Mountain, 16; near Blythe, 2; above Ehrenberg, 1; opposite Cibola, 35; twenty miles above Picacho, 10; eight miles below Picacho, 8; Potholes, 1; four miles below Potholes, 1; five miles northeast of Yuma, 5; near Pilot Knob, 8. Arizona side: Mellen, 12; above Bill Williams River, 2; Ehrenberg, 16; twenty-five miles below Ehrenberg, 3; ten miles below Cibola, 27; five miles northeast of Laguna, 8; near Yuma, 6.

In addition, the Museum contains four skins (nos. 5636, 5637, 5825, 5826) taken in 1861 by Dr. J. G. Cooper at Fort Mohave, on the Arizona side twelve miles above Needles.

It is at once patent that of the five distinct species of *Perognathus* found along the lower Colorado, *P. penicillatus* is both most abundant and most widespread. Very many more individuals were trapped day by day than were preserved.

It may be asked why explicit record is not here presented, not only of specimens saved, but of *all* the individuals trapped. The reason is that so similar in external appearance are the various species of *Perognathus*, that especially with our previous unfamiliarity with them, we were liable to many mistakes in identification in the field. After museum study was made of the suites of specimens brought home, with skulls cleaned and measurements tabulated, it was found that errors had actually occurred in a number of cases thus checked up. *Perognathus penicillatus* and *P. intermedius* had been confused on the Arizona side, and *P. penicillatus* and *P. formosus* on the California side, especially in the cases of immatures. Field determinations were therefore totally disregarded.

It may scarcely be necessary to remark that *penicillatus* (plus *angustirostris*, if the form designated by the latter name be considered tenable), *intermedius*, *spinatus*, and of course *formosus*, are all distinguishable with absolute certainty (for characters see Osgood, 1900). No difficulty was experienced in allocating all specimens as soon as cleaned skulls were available.

Although obtained at all collecting stations and from all associations, reference to the graph for frequency of occurrence (see fig. D) clearly shows that *Perognathus penicillatus* has marked preferences for one particular environment. This preferred habitat is characterized by ground of fine-grained sand. The second bottom along the river and the broad washes of the flatter parts of the desert furnish the ideal conditions; and in the most typical of these *penicillatus* is either the exclusive or the prevailing member of the genus present.

Penicillatus is the only species invading alkali depressions at the edges of the broad valleys back from the river (where *Suaeda* grows), and is the only species occurring regularly on parts of the overflow area of the river bottom. Referring again to the frequency record (fig. D), it is shown that *penicillatus* was found in every member of the riparian group of associations, even into the willows. Individuals were always, however, as far as record and memory serves to estab-

lish the point, trapped on dry surfaces, indicating a preference for dryness. On thoroughly dried-out, rather high sand banks along the river where the bottom strip was narrow, sign was noted to within a few feet of the edge of the swift current. Individuals were trapped on sand bars, at the time high and dry, but so slightly elevated that rising water would at first form islands of them and then engulf them completely.

No doubt, as with *Peromyscus*, aggressive individuals of *Perognathus penicillatus* are often thus caught and set adrift, thus giving a chance for transfer from one side of the stream to the other. As discussed in a general way elsewhere, there seems to be significant correlation between the fact of this free invasion of the river bottom and existence and similarity of the representatives of the species on both sides of the river.

The breeding season of *penicillatus* is of greater duration than that of the other pocket mice of the region, as shown by the following data. A female taken April 19 contained five embryos; another taken May 4 contained four embryos. Gray-coated young-of-the-year were taken as early as March 5 and at intervals from then on through April and into May.

After study of the Colorado River series in connection with the 120 additional specimens in the Museum from various localities in the Salton Sink region of the Colorado desert, I have come to the conclusion that the recognition of the name *angustirostris* as applying to any of the Colorado River specimens is impracticable. Osgood (1900, pp. 45–47) described a race *angustirostris* from the Colorado desert, type locality Carriso Creek, west side of the desert. The Museum has a good topotype series, and also a series from Mecca, in the bed of the Salton Sink at the northwest end of Salton Sea.

The characters assigned to "*angustirostris*" were, as compared with *penicillatus*, small size, less massive skull, and longer and more slender rostrum. Osgood referred his few specimens from the Colorado River, from Ehrenberg and above, to *penicillatus*, while those from Fort Yuma and all localities to the west he listed under *angustirostris*.

Close scrutiny of the extensive material now at hand shows great instability in all the alleged characters. There is as notable fluctuation in size from place to place up and down the river, as across the Colorado desert. The topotypes of *angustirostris* include some skulls as massive as many from Mellen, Arizona.

One thing is apparent, that the Mecca series includes more small specimens, with narrow-snouted skulls, than series of like extent from elsewhere. There is thus a *tendency* towards the existence of a race, of the characters assigned by Osgood to his *angustirostris,* in Salton Sink. But if the upper Colorado Valley specimens are *penicillatus,* so also are those from all the way down to Yuma and Pilot Knob and thence across to the east flank of the Coast Range in eastern San Diego and Riverside counties.

In view of the locally fluctuating variations through the region under consideration, the inclusion of all under the one name *penicillatus* seems now the wisest course. Should the *penicillatus* of Woodhouse prove to represent a truly distinct race, occupying the elevated north central deserts of Arizona, as hinted by Osgood, then *angustirostris* would be the name to be used for the subspecies of *penicillatus* occurring all along the Colorado Valley below the Grand Cañon, and through the Colorado desert.

Perognathus intermedius Merriam

Intermediate Pocket Mouse

A series of 82 specimens taken, nos. 9876–9955, saved as skins-with-skulls, and nos. 10785, 10786, as alcoholics. The localities of capture were all on the Arizona side of the river, as follows: Mellen, 19; foot of The Needles, 10; above Bill Williams River, 2; Ehrenberg, 13; twenty-five miles below Ehrenberg, 1; ten miles below Cibola, 27; five miles northeast of Laguna, 10.

The preferments of this pocket mouse are to all appearances identical with those of the Harris ground squirrel. Both rodents are restricted to rocky hills and the hard-surfaced, coarse-graveled mesa. In both situations scattering creosote bushes form the prevailing vegetation, though on the hills *Encelia farinosa* is an additional conspicuous plant. *Perognathus intermedius* was in no case found so near the river as the second bottom (see diagram, fig. E). In fact, only three out of the 82 individuals caught were found in sandy desert washes, and these could have readily reached the points of capture in foraging down from home centers on adjacent hills or mesa.

Our series of record stations, as above named, carry the known range (see Osgood, 1900, pp. 52, 53) of *P. intermedius* to the west, and mark its limits in that direction as being at the east side of the

Colorado River bottom. The presence of the species was ascertained at every station where appropriate ground was trapped, from Mellen nearly to the Laguna dam.

Among all the specimens taken, only two were juvenals. These were taken above Laguna on April 24 and 25. None of the numerous females taken earlier in the season contained embryos, so that the breeding season would appear to be deferred in the case of this species until the advent of hot weather.

Perognathus spinatus spinatus Merriam

Spiny Pocket Mouse

This pocket mouse was found only on the California side of the river. A series of 125 specimens was taken, nos. 9536–9651 (skins-with-skulls), 10713, 10714 (skeletons), 10787–10793 (alcoholics). Localities are represented as follows: opposite The Needles (practically topotypes of the species), 14; Chemehuevis Valley, 1; Riverside Mountain, 26; opposite Cibola, 36; twenty miles above Picacho, 32; eight miles east of Picacho, 6; Potholes, 4; Pilot Knob, 6.

The spiny pocket mouse proved to have much the same associational preferments as the antelope ground squirrel, namely, the hills and rough-surfaced mesas of the desert. It was found close to the river only where the riparian bottomland associations were pinched in to merest traces of their elements by the abutment of the hills. Places of this nature, where *spinatus* was caught within as near as a hundred yards of the water's edge, and yet on ground perfectly appropriate to the species, were opposite The Needles and twenty miles above Picacho.

At the latter locality the only exception to the above statements came to notice. An adult female was caught among the willows on first bottom and within seventy-five feet of the water, hence where proper conditions of topography and rising water *might* have resulted in transporting the animal to the opposite side of the river. But the excessive rarity of such a combination of circumstances probably accounts for the fact that *Perognathus spinatus* has never been found to the east of the Colorado River. The strip of bottomland at the point where this wanderer was captured was only about three hundred yards wide, and the species was found to occur commonly on the hillsides down to the outer edge. The individual probably occurred merely as a forager.

Opposite Cibola, as already noted under *P. formosus*, the spiny pocket mouse occurred on a broad desert wash, strewn with boulders. Specimens were trapped there, not only among boulders but around scraggly stumps of ironwood.

The breeding season apparently does not begin till April. On the 13th and 19th of that month females taken contained four embryos each. On April 28 and May 9 half-grown young were trapped.

Lepus californicus deserticola Mearns

Colorado Desert Jack Rabbit

The eight specimens secured (nos. 10682–10689) came from the following localities: California side: five miles below Needles, twenty miles above Picacho, and near Pilot Knob; Arizona side: Ehrenberg, and five miles north of Laguna. Specimens from the two sides of the river are identical as far as I can see; and this is to be expected. For although the jack rabbit belongs primarily to the desert mesas, it forages also all over the flood-bottoms. I was told that this species of rabbit swims strongly when forced to take to the water.

Jack rabbits occurred through the region in 1910 in very small numbers. At some stations none at all were seen, though old sign was usually plentiful. The greatest numbers were observed on the mesa back of Ehrenberg, but not more than half a dozen could be seen during a three hours' circuit.

Two females shot near Ehrenberg, March 28 and 29, contained two and three embryos respectively.

The weight of an adult male (no. 10682) was four pounds, fourteen ounces; of an old female (no. 10683) six pounds.

Sylvilagus auduboni arizonae (J. A. Allen)

Arizona Cottontail

The year of our exploration of the Colorado Valley was stated by the residents of the region to be an off-year for both jack rabbits and cottontails. Whatever the usual conditions, both kinds of rabbits were unexpectedly scarce.

The cottontails were chiefly riparian in their local distribution. In fact, the only individuals seen desertwards beyond the mesquite belt were in the salt-bush association closely adjacent, and (opposite The Needles) up a catclaw wash not to exceed one-half mile from the river.

The quail-brush association was the most preferred local habitat, the rabbits finding ideal refuges there beneath the thickets of *Atriplex lentiformis*. They ranged all over the bottomlands, and since individuals were seen on islands already cut off by rising water from mainland connection, it is probable that many rabbits are washed adrift each year and are carried from side to side of the river. We were assured that cottontails had been seen swimming in the river during flood time.

We procured twenty-one specimens of the cottontail (nos. 10661-10681), representing the following localities: Arizona side: Mellen, foot of The Needles, five miles northeast of Laguna; California side: opposite The Needles, Riverside Mountain, Blythe, opposite Cibola, eight miles east of Picacho, five miles northeast of Yuma, near Pilot Knob. A close examination of the comparable specimens from the two sides of the river shows no differences. This is explainable on the ground that to the distribution of this rodent the river forms no permanent hindrance.

The weight of an adult male (no. 10678) was 24 ounces, of an adult female (no. 10679), 26 ounces; both shot near Mellen.

Partly grown young were caught March 20 and April 3. A female taken May 6 contained two large embryos.

Felis oregonensis browni Merriam

Yuma Cougar

We were told of the occurrence of cougars at several points along the river from Riverside Mountain south. They appear to range chiefly through the densely wooded bottomlands. One, however, was reported as having been seen in the rough hills constituting Riverside Mountain. In the vicinity of Ehrenberg, Cibola, and Potholes I was given more or less definite accounts of them. At a point on the California side four miles below Potholes, we saw fresh footprints of one within fifty yards of the main river channel.

From a rancher, J. C. Draper, who lives on the California side, eighteen miles north of Picacho, I purchased two skins with skulls, with the following history. Mountain lions had not been previously seen in his neighborhood for at least ten years. In the autumn of 1909 his hogs began to disappear, until eight were gone. Finally the tracks of a lion were found, and then the fresh trail where a 125-pound hog had been dragged a quarter of a mile through the brush. The beast was discovered nearby, treed by a dog, and shot. This was on

the California side of the river one and one-half miles below Draper's house, about November 15, 1909.

Meanwhile the hogs had become thoroughly frightened and had taken to swimming the river twice daily, to forage for mesquite beans on the Arizona side, where they appeared to feel safer. But in December traces of a lion were discovered on that side. After a pig and a coyote had been killed by the lion, the latter was trailed and treed by a dog, and shot by Draper. This was directly opposite the Draper house, on December 29, 1909. Draper stated his belief that the lions swam back and forth across the river at will.

Both lions were males, the first (no. 10586) measuring before skinning, 6 feet 6 inches in length, the second (no. 10587) 6 feet 4 inches. The skull of the first is imperfect, the whole base having been shot away; but that of the second is entire. The skins are flat, in fairly good condition, and measure, as now tanned, no. 10586: total length 2120 mm., tail 680; no. 10587: total length 2085, tail 710.

They show the following characters. Pelage: short, fine-haired and smooth; longest hairs on middle of back 17 mm. in no. 10586, and 24 mm. in no. 10587 (in *oregonensis* from western California the pelage is much heavier and coarser, 28 mm. long); tail slender due to shorter clothing of hair (much more bushy in Pacific slope *Felis*). Coloration pale: clay color on upper parts deepening towards hazel down middle of back, and becoming whitish on mid-lower surface and on insides of legs and thighs. Close examination discloses an admixture middorsally of black-tipped tawny hairs and fewer pure white hairs; but uniform pale hazel hairs predominate. Outer sides of legs and tops of feet, pale clay color; hair of soles of feet between pads, prout brown. Tip of tail dorsally (in both specimens), dark burnt umber for about 50 mm. from tip; tail otherwise dusky tawny dorsally and pale clay color ventrally. Back of ears blackish, dulled because of admixture of white hairs, especially towards tip and inner margin. Ears relatively lightly clothed. Face pale, of color of back but duller; black patches at bases of whiskers not conspicuous, much mixed with whitish. Whiskers wholly white, except three or four dorsalmost ones which are blackish, light tipped.

While the skulls are small (see accompanying table of measurements) as compared with *oregonensis* of western California, they are larger than the type of "*Felis aztecus browni*" (Merriam, 1903, p. 73) as shown by the describer's measurements in the two particulars given by him. They agree much more closely with the measurements

given of the type of *Felis hippolestes azteeus* (Merriam, 1901, p. 593). Since the sagittal crest of our no. 10587 is very highly developed, it may be an older animal. Merriam's transverse diameter of bulla in the type of *browni* is 16 mm., while in our smallest specimen it is 19; his upper carnassial length in *browni* is 20.5; in our least it is 21.5, which, however, belongs to the otherwise largest skull. The type of *browni* came from the Colorado bottom, Arizona, twelve miles below Yuma.

There thus appears to be considerable variation, and it is probable that there is really less to distinguish *browni* from *aztecus* than the original description of the former indicates. However, our material proves that there *is* a well-marked desert form of the cougar, characterized, as compared with *oregonensis*, by smaller size, paler coloration, and shorter pelage.

CRANIAL MEASUREMENTS IN MILLIMETERS OF *FELIS OREGONENSIS BROWNI* FROM THE COLORADO VALLEY

Mus. no.	Sex	Greatest length	Basilar length of Hensel	Zygomatic width	Interorbital constriction	Nasals	Width between tips of post-orbital processes	Occipito-nasal length	Height of skull: frontals above palatines[1]	Occipito-sphenoidal length	Transverse diameter of bulla from meatus to front of foramen lacerum posterius	Under jaw, anterior symphysis to posterior condyle	Greatest length of left upper carnassial	Greatest diameter of left upper canine
10586	♂	.....	.....	.....	43.5	48	72	.....	77	....	....	144	21.7	13.6
10587	♂	198	161	127.5	36.0	41	61	180	73	62	19	134	22.5	12.7

[1] Measured from plane of inferior surface of palatines vertically to highest point on dorsal surface of frontals.

Lynx eremicus eremicus Mearns

Desert Wildcat

Two bobcats were trapped by our party: a female (no. 10604) in a patch of screwbean trees in the river bottom on the California side five miles below Needles, February 21; and a male (no. 10605) in a wash lined with palo verde and catclaw on the Arizona side north of Mellen, February 27. In addition to these specimens, both saved as skins and complete skeletons, there is in the Museum a skin with the skull inside (no. 5620) taken by W. W. Holder at Mineral City (=Ehrenberg), Arizona, in 1864.

The three skins agree in relative pale tone of coloration as compared with appropriately selected material from the Pacific slope of southern California (=*Lynx eremicus californicus*). The paleness consists in more extended white-tipping to the hairs. The Mellen specimen is slightly the darkest; but there is as much or more variation in skins from a single locality elsewhere.

The measurements, in-the-flesh, of the two taken in 1910 are:

Mus. no.	Sex	Total length	Tail vertebrae	Hind foot	Height of ear	Tuft of hair on ear
10604	♀	815	150	175	63[1]	25[1]
10605	♂	780	150	170	75	26

[1] Measured on dry skin.

There are in the Museum three skins of wildcats from Victorville on the Mohave Desert, which are also somewhat pale in comparison with Pacific Slope skins. Aside from this character of paleness, I am unable to find any other diagnostic features in wildcats of the desert region, even after carefully following Mearns's description (1897, p. 457). *Eremicus* and *californicus* are certainly very close, though present material appears to me to warrant separate recognition (see Stephens, 1896, pp. 210, 211).

The weight of the male wildcat caught near Mellen was 18 pounds. The stomach of this animal contained the fragments of at least two wood-rats. These had not been chewed finely, but had been chopped up into chunks about an inch long; the feet were still entire.

Canis ochropus estor Merriam

Desert Coyote

Coyotes were only fairly common along the Colorado Valley. They were occasionally seen on the desert mesas by daylight, but were rarely heard. It was evident from tracks on the mud bars that they foraged down to the river's edge at night.

The six specimens secured (nos. 10611–10616) represent the following localities, all on the California side: five miles south of Needles, opposite The Needles, twenty miles north of Picacho, and Pilot Knob.

The weights of three adult males were 16, 18, and 21 pounds; of two females, 18 and 20 pounds.

Vulpes macrotis arsipus Elliot

Desert Kit Fox

This fox appeared to be a characteristic element in the purely desert fauna. The five specimens taken were all trapped on the desert mesas back from the river. In fact, no evidence at all was forthcoming to show that kit foxes ever visit the river or even the bottomlands. Their presence was generally detected in sandy tracts, especially around colonies of *Dipodmys deserti*. It is to be inferred that this rodent constitutes the main food-supply of the kit fox in localities where both occur.

The accompanying table shows the data appertaining to the specimens caught. Although a xerophilous species, examples from opposite sides of the river do not differ appreciably, in either cranial or external characters.

The two females taken at Pilot Knob showed evidence of having recently suckled young, though this stage was well passed.

LIST AND MEASUREMENTS IN MILLIMETERS OF *VULPES MACROTIS ARSIPUS* FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Weight lbs.	Length	Tail vertebrae	Hind foot	Ear
10581	♀	Mellen, Ariz. side	Feb. 26	2 1/16	670	260	110	80
10582	♀	Ehrenberg, Ariz. side	Mar. 27	3	725	290	120	85
10583	♂	Opposite Cibola, Calif. side	Apr. 5	..	740	290	115	92
10584	♀	Near Pilot Knob, Calif. side	May 10	3 1/3	720	280	115	....
10585	♀	Near Pilot Knob, Calif side	May 15	3	724	297	108	86

Urocyon cinereoargenteus scotti Mearns

Arizona Gray Fox

The Colorado River bottom and nearby desert proved to be well populated with a form of gray fox. Specimens were taken, as shown in the accompanying table, on both sides of the river. Besides the localities represented by specimens, gray foxes were also seen on the California side near Pilot Knob; so that the species doubtless occurs continuously the whole length of the portion of the river explored by us.

Our Colorado River material added a subspecies to the known mammal fauna of the state. *Urocyon c. scotti* is well distinguished from *U. c. californicus*, of the San Diego district, on the basis of

LIST AND MEASUREMENTS IN MILLIMETERS OF ADULT SPECIMENS OF *UROCYON CINEREOARGENTEUS SCOTTI* FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Length	Tail	Hind foot	Ear	Weight (lbs.)	Basilar length of Hensel	Zygomatic width	Width of rostrum at narrowest part posterior to base of canine	Greatest width of braincase	Length of tooth row: last molar to incisors, inclusive	Diameter of bulla[1]
10594	♀	Needles, Calif.	Feb. 17	930	405	130	....	..	105.5	64.8	17.2	44.8	57.4	12.1
10595	♀	Mellen, Ariz.	Feb. 27	938	416	132	82	..	101.4	61.5	16.1	42.5	59.2	13.5
10596	♂	Foot of The Needles, Ariz.	Mar. 6	975	435	132	87	6¾	106.5	63.7	16.5	42.1	60.0	12.2
10597	♀	Opposite The Needles, Calif.	Mar. 3	950	420	130	75	6	109.5	63.3	17.4	44.8	60.3	12.6
10598	♂	Opposite The Needles, Calif.	Mar. 3	940	415	125	80	7	107.6	63.7	17.2	44.9	59.3	12.8
10599	♂	Opposite The Needles, Calif.	Mar. 5	1000	425	137	80	7	108.7	64.4	17.1	44.2	59.3	12.2
10600	♂	Chemehuevis Valley, Calif.	Mar. 9	935	405	130	80	8	102.3	64.0	17.4	45.2	62.0	12.1
10601	♂	Chemehuevis Valley, Calif.	Mar. 10	940	390	130	80	7	109.5	64.7	17.2	45.9	60.9	13.0
10602	♂	20 mi. N. Picacho, Calif.	Apr. 15	948	390	124	86	6½	108.2	63.5	17.0	44.8	60.4	12.6
		Average		951	411	130	81	7	106.5	63.7	17.0	44.3	59.8	12.6

[1] Minimum distance between foramen lacerum posterius and anterior notch of meatus.

both external and cranial characters. *Scotti*, as exemplified by the Colorado River series, has a longer tail, higher ear and paler coloration; the rufous tinges are less bright; the white endings of the hairs on sides of body and tail and on top of head are more extensive, giving a grizzled effect in the desert race. The skull of *scotti* is of relatively lighter build; the teeth are smaller, being more slender and hence sharper; the auditory bullae are more inflated, that is, relatively higher and steeper-sided; the rostrum is conspicuously narrower. For measurements of *californicus* see Dixon (1910, p. 304) and for discussion of relationships see Grinnell and Swarth (1913, p. 373).

Mephitis estor Merriam

Arizona Striped Skunk

A common species in the riparian strips along both sides of the river. Data pertaining to the eight specimens obtained is given in the accompanying table. This animal evidently does not stray out on to the open desert, being probably kept to the bottomlands by daily need for water; nor has it the physical ability to cover much distance in a night's travel. Those caught were in mesquite, screwbean, willow or arrowweed tracts. Tracks were often seen on the mud at the water's edge.

A male, no. 10576, weighed three pounds, two ounces. The female taken near Pilot Knob May 12 contained four foetuses.

This species of *Mephitis* is distinctly smaller than *M. occidentalis*. Although in all of the six skins of *estor* from the Colorado Valley there is much more white than in *occidentalis*, the amount varies individually to a large extent. In five out of the six there is a white pectoral patch, and in four of these there are additional flecks of white mid-ventrally. The longer hairs of the tail are in each case fully white; but a thick growth of relatively short hairs clothing the tail is black terminally, white at base. As the season advances it looks as though the long white hairs of the tail tend to be shed, leaving the tail of a darker tone, until the black even predominates.

The mid-frontal white streak varies in amount, but averages greater than in *occidentalis*. The dorsal white area (*creamy* white) is unbroken in no. 10575; in no. 10574 there are tufts of black in the mid-dorsal line over the rump; in the other four skins there is a well-defined black stripe separating the white into two lateral stripes

which join on the shoulders, and continue forward to cover the whole back part of the head behind an abrupt line of demarcation joining the ears. (See pl. 13, fig. 21.)

The question suggests itself whether or not geographic variation in proportion of white and black (as in *Mephitis estor* of the desert as compared with *M. occidentalis* of the Pacific slope of California) is correlated with the maximum condition of efficiency from the standpoint of utility. Granted that the sole purpose of the skunk's contrasted markings is to offer a signal of warning, then the maximum of efficiency will be reached when the proportion of black and white is such as to bring the greatest degree of conspicuity amid the average of the natural surroundings.

The surroundings on the desert, even in the riparian thickets, are far lighter-toned both night and day, than they are in the humid coast region. It would seem, therefore, that to secure the greatest conspicuity the increased proportion of white must be provided for the darker surroundings, and conversely the increased amount of black must be presented in the lighter surroundings. This is the reverse of the case in fact. Hence it looks as though the warning theory does not gain substantial support from this direction.

The problem of the significance of animal coloration promises important results when attacked upon a basis of the facts to be observed in geographic variation.

LIST AND MEASUREMENTS IN MILLIMETERS OF *MEPHITIS ESTOR* FROM THE COLORADO VALLEY

Mus. no.	Sex	Nature of material	Locality	Date	Total length	Tail vertebrae	Hind foot	Ear
10574	♀	Skin and skeleton	Calif. side, 5 mi. south of Needles	Feb. 23	665	300	65	15
10575	♀	Skin and skeleton	Calif. side, Chemehuevis Valley	Mar. 9	625	300	70	25
10576	♂	Skin and skull	Arizona side, foot of The Needles	Mar. 5	642	330	70	23
10577	♂	Skull only	Arizona side, Ehrenberg	Mar. 26	625	300	68	18
12648	♂	Skeleton only	Arizona side, Ehrenberg	Mar. 24	610	288	71	17
10578	♂	Skin and skull	Calif. side, opposite Cibola	Apr. 6	525	300	70	25
10579	♀	Skin and skull	Calif. side, 20 mi. N. of Picacho	Apr. 12	615	322	69	20
10580	♀	Skin and skull	Calif. side, near Pilot Knob	May 12	595	280	64	22

Spilogale arizonae arizonae Mearns

Arizona Spotted Skunk

We were told of the presence of "hydrophobia" skunks among The Needles, Arizona. Mr. Stephens saw tracks of one in the river bottom on the California side five miles below Needles. The species is certainly not common, or our traps would have given more indication of its presence. The only specimen procured by our party was trapped in the arrowweed belt within one hundred yards of the river, on the California side at our last station, close to Pilot Knob. It is an adult male (no. 10573) with following external measurements by collector (Stephens): length 440, tail vertebrae 170, hind foot 46, ear 22, weight 18 oz. The cranium measures: basilar length 49.8, zygomatic breadth 36.1, mastoid breadth 30.9, interorbital width 14.4, height of brain-case (as measured by Howell, 1906, p. 37) 17.8.

I sent this skin-with-skull to the Bureau of Biological Survey, Washington, where Mr. A. H. Howell determined it to be "*arizonae* but not typical." He further considered it "as grading toward *martirensis*," which, from its geographical location, is quite to be expected (see Howell, 1906, pp. 29, 30, pl. 1). The present record is the basis of the first assignment of *arizonae* to Californian territory.

Taxidea taxus berlandieri Baird

Mexican Badger

While no badgers were secured by our party directly, I purchased a flat skin, with skull, of a young one at the Barber Ranch twenty miles above Picacho. This had been killed on the California side in the autumn of 1909. Badgers were reported as frequently seen in the vicinity of the Draper ranch, eighteen miles north of Picacho, and also on the Arizona side in the neighborhood of Cibola.

The skin secured (no. 10603) as compared with one of about the same age from Ventura County, California (no. 7078), is very much paler. The individual hairs have longer white tips, and a mid-dorsal white stripe extends from top of nose to rump. In the Ventura County specimen there is a white stripe from tip of nose to between shoulders, only. The skull of no. 10603 is smaller, doubtless due to younger age, but it appears to be also of relatively lighter build.

Procyon pallidus Merriam

Pallid Coon

An abundant representative of the riparian association everywhere. The accompanying list shows localities of capture from Needles to Pilot Knob, and also from one of the Colorado's distributaries, New River, in the delta region near Imperial, California.

At practically every place where we had occasion to examine the muddy margin of the river or its lateral sloughs, the conspicuous footprints of coons were to be seen. One coon was caught in an unbaited trap set for beaver beneath the surface of the water, at the river's edge.

The chief food of the coons was evidently fish. At a drying-up overflow pond, the shallow water of which was crowded with catfish, a profusion of the tracks of herons and coons showed a marked community of interests on the part of these two fishers.

No young-of-the-year came to notice. The female caught May 11 near Pilot Knob contained four embryos. The one caught near Imperial May 10 contained five embryos. The weight of the female no. 10610, was 16 pounds. Two fat males, nos. 10606, 10607, weighed 18½ and 18 pounds respectively. A lean male, no. 10609, weighed but 13 pounds. The very large old male (no. 7153), from near Imperial, weighed 20 pounds.

In the original description of *Procyon pallidus* (Merriam, 1900, p. 151), both external and cranial characters of this form are given. The cranial peculiarities mentioned, as compared with *Procyon psora*, do not appear to hold in our material. There is much variation in the respects mentioned, as will be understood from the table of measurements. In coloration alone, however, there is abundant basis for the recognition of *pallidus*.

The seven skins from the Colorado Valley, including Imperial Valley, although somewhat variable in coloration, are in mass effect conspicuously different from the coons of the Pacific Coast region. A large series of skins of the latter are available for comparison; and even selecting extremes from the *pallidus* and *psora-pacifica* series, no overlapping of characters can be found in the material at hand.

The general pallor of *pallidus* as compared with *psora* is due to: (1) The far less amount of black on the individual hairs everywhere except on the nose and cheeks. This is the converse of saying that much more of each hair is white. Along the sides, on the ears and on the light intervals between the tail-rings the hairs are pure white with no black tippings. (2) The black areas are less in extent. The

seven or eight black tail bars are narrower, thus making the light intervals broader; the whole tail is thus very much lighter colored. (3) The "black" color of the hairs is in many places not so intense, being, particularly on the tail and head, of a deep vandyke brown. Fading evidently brings a browning of the dark hairs to some extent. (4) The under fur is very much paler in color. Dorsally it is vandyke brown instead of bistre; on the sides and belly it grades through cinnamon to pale clay color. In the facial region the typical coon pattern is present, but the white markings are not so conspicuously contrasted. This is due to the less intense black, and to the fact that the pileum is scarcely darker than the rest of the back. The post-mental area and the median nasal stripe are rather pale vandyke brown. Only the transocular black patch is retained in nearly its usual distinctness. The whiteness of the backs of the ears is a notable feature; and there is altogether lacking the black patch behind the ears usually so well marked in *psora*.

In a general way *pallidus* thus differs from *psora* in very much paler coloration. The two specimens from the vicinity of Imperial are topotypes of *pallidus*, and accord closely with the brief description of the form as given by Merriam. These two topotypes are the palest of our *pallidus*, but it will be observed from the list that they were secured in May. As might be expected from this circumstance, they had evidently been subjected to much more wear than especially our Needles and Mellen specimens, which are somewhat darker. It is easy to see that the cutting off of the black tips of the long hairs in the latter, particularly on the mid-dorsal region, would result in a decided paling in the general color.

Eliminating this factor of wear, and the slight amount of fading which very probably occurs (even though these nocturnal animals may not be exposed to intense sunshine to any large extent as they probably spend the day in drift piles or thickets rather than in trees), I cannot see that those specimens from farthest up the river are any paler than those from farther down the river, or than the topotypes.

It would not be reasonable, therefore, to hold that the apparently darker animals farthest up the river from the assumed center of differentiation (Colorado delta) indicate intergradation with darker coons to the northward, even though this might be expected. It is even possible that the cliff-confined river above forms an effectual barrier to the north, so that there has been little chance of mingling of coon strains from elsewhere. *Pallidus* may be hemmed in by ordinarily uncrossable barriers, and hence has attained a clear-cut specific identity.

LIST AND MEASUREMENTS IN MILLIMETERS OF *PROCYON PALLIDUS* FROM THE COLORADO VALLEY AND DELTA

Mus. no.	Sex	Locality	Date	Length	Tail	Hind foot	Ear	Basilar length of Hensel	Zygomatic width	Width of rostrum at narrowest part back of base of canine	Interorbital constriction	Postpalatal length	Mastoid width	Palatine constriction	Width of jugal beneath orbit
7152	♀ old ad.	6 mi. W. of Imperial, Calif.	May 10[1]	860	305	133	56	111.1	81.5	26.4	24.2	40.0	66.2	16.4	9.7
7153	♂ old ad.	6 mi. W. of Imperial, Calif.	May 8[1]	910	288	138	59	117.2	89.3	30.7	27.6	43.5	71.5	16.9	13.0
10606	♂ old ad.	5 mi. S. of Needles, Calif.	Feb. 23	855	300	121	54	111.2	84.8	28.5	25.8	41.7	68.8	16.8	11.3
10607	♂ yg. ad.	Mellen, Ariz.	Mar. 1	885	310	131	71	111.5	82.1	29.4	26.8	40.0	64.7	16.7	11.7
10608	?	20 mi. N. of Picacho, Calif.	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....
10609	♂ yg. ad.	Potholes, Calif.	Apr. 28	870	330	125	60	106.0	78.4	25.7	23.3	38.1	64.3	15.7	9.8
10610	♀ old ad.	Ariz. side, opp. Pilot Knob	May 11	870	300	120	46	104.6	82.7	26.5	24.9	38.4	65.0	16.2	9.8

[1] Collected in 1909 by F. Stephens; the rest obtained on the 1910 Expedition.

Corynorhinus macrotis pallescens Miller

Pale Lump-nosed Bat

At Riverside Mountain, California, March 18, three bats were found at the end of a sloping drift in the Steece copper mine. They were clinging to the rock wall, and at once took flight, attempting to pass us towards the opening of the tunnel. Two were secured, nos. 10694, 10695. The fur of these has a slight reddish cast, which is doubtless wholly adventitious, due to the fine, sticky red dust with which the walls of the mine were covered. Both were females, one of them containing a single embryo.

Antrozous pallidus pallidus (LeConte)

Desert Pallid Bat

On several nights in April, large light-colored bats were momentarily observed flitting about in the moonlight close over our beds. At times the flutter of their wings was clearly audible. But they seldom appeared until it was too dark to shoot. On April 20, on the California side, eight miles east of Picacho, a specimen was shot at late dusk as it flew among willows across a patch of open sky. This, the only example of the species obtained (no. 10696), was a female containing two embryos.

Myotis occultus Hollister

Hollister Bat

This very distinct species was only recently described (Hollister, 1909, p. 43) from two specimens taken May 14 and 15, 1905, on the California side of the river in the bottomlands ten miles above Needles. The fact that our own expedition failed to detect the presence of this bat until the first week in May would point towards its late spring arrival in the region generally. We obtained six specimens, as listed in the accompanying table of measurements. The first was shot at late dusk close to the river bank between files of cottonwoods, in just the same association as those taken by Hollister. At our second locality of capture, the remaining five specimens were shot over the water in a back eddy of the river. Here these bats arrived in considerable numbers at early dusk to drink, flitting down to the water's surface and dipping several times before flying off among the willows and cottonwoods. We used a boat in shooting and retrieving the specimens obtained.

MEASUREMENTS IN MILLIMETERS OF *MYOTIS OCCULTUS* FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Total length	Tail vertebrae	Hind foot	Thumb	Forearm	Length of cranium over all	Zygomatic breadth	Breadth of brain-case	Interorbital constriction	Maxillary tooth-row
10702	♀	4 mi. S. of Potholes, Calif.	May 1	85	35	9	5.9	35.4	15.2	9.8	7.7	3.9	5.8
10703	♀	5 mi. N.E. of Yuma, Calif.	May 3	89	34	8.9	5.3	35.5	.....	9.7	....	4.1	5.9
10704	♀	5 mi. N.E. of Yuma, Calif.	May 3	90	36	9	6.0	36.4	15.4	10.1	7.9	4.0	5.8
10705	♀	5 mi. N.E. of Yuma, Calif.	May 4	86	34	8.5	6.1	35.2	14.8	9.6	7.3	4.1	5.8
10706	♂	5 mi. N.E. of Yuma, Calif.	May 3	87	37	8	5.2	36.3	15.3	9.6	7.6	4.0	5.7
10707	♀	5 mi. N.E. of Yuma, Calif.	May 4	87	38	9	5.4	35.1	15.0	9.8	7.7	4.0	5.8
		Average of the six adults		87.3	35.7	8.7	5.6	35.6	15.1	9.8	7.6	4.0	5.8

I sent one example to the Bureau of Biological Survey, where Mr. A. H. Howell made the specific determination here employed. Our series bears out closely the characters assigned in the original description (Hollister, 1909, p. 43), and they are in all these respects surprisingly uniform. The very broad and flat-topped rostrum and braincase constitutes a character for discrimination from all other species of *Myotis* in California except *orinomus*. The proportions generally are peculiar (see table of measurements).

Fig. H. Right upper dental series of *Myotis occultus*, no. 10702, ♀; middle upper premolar absent. × 4.

Fig. I. Right upper dental series of *Myotis occultus*, no. 10706, ♂; middle upper premolar present. × 4. Variation in general proportions from those of preceding figure possibly due to age.

An interesting fact pointed out by Hollister is the variability in a feature usually considered of much more fundamental importance than the external characters employed in distinguishing members of the genus, namely, the presence or absence of the middle upper premolar (pm^3). In one of Hollister's specimens this tooth was present, in the other absent; in three of ours it is present, in three it is wanting. Thus fifty per cent of the individuals so far collected lack the tooth in question, certainly a remarkable aberrancy from the norm in the genus *Myotis* (see Miller, 1907, p. 201), and denoting a tendency to specialization in this member of the genus, along a line regularly shown in other closely related genera (see figs. H, I).

Myotis californicus pallidus Stephens

Stephens Little Pallid Bat

The accompanying table shows certain circumstances of capture of this species. Although obtained at but the two localities, Mellen, on the Arizona side, and opposite The Needles, on the California side,

I was fairly sure that I saw the same species at other localities along down the river. Those obtained were all shot at late dusk, considerably later in the evening than most of the appearances of *Pipistrellus hesperus*. Instead of flying high, against the sky, as in the case of the latter species, *M. c. pallidus* was almost always foraging low over the bushes of the second bottom, or along shallow washes between clumps of mesquite, seldom appearing above the sky-line. The movements of flight were peculiar also.

LIST AND MEASUREMENTS IN MILLIMETERS OF *MYOTIS CALIFORNICUS PALLIDUS* TAKEN IN 1910 ON THE COLORADO RIVER

Mus. no.	Sex	Locality	Date	Length	Tail vertebrae	Hind foot
10698	♂	Mellen, Ariz.	Feb. 26	75	38	5
10699	♂	Mellen, Ariz.	Feb. 28	77	38	6
10700	♂	Opposite The Needles, Calif.	Mar. 1	81	40	6
10701	♀	Opposite The Needles, Calif.	Mar. 3	75	35	6

The four specimens obtained are uniform among themselves and with a topotype specimen of *Myotis californicus pallidus* (no. 7350) from Vallecito, on the western side of the Colorado desert in extreme eastern San Diego County. All agree closely with the description of *M. c. pallidus* (Stephens, 1900, p. 153). An additional feature, as compared with *Myotis californicus californicus* from Monterey, California, is the smaller skull of *pallidus*, with decidedly smaller braincase, less inflated in the parietal region.

Myotis velifer (J. A. Allen)

Cave Bat

Not obtained by our party; but there are in the Museum three skins-with-skulls (nos. 7762–7764) taken by Charles Camp at Needles July 16 and 18, 1909. Mr. Camp states that this species was roosting in numbers in an old storehouse from which they were routed out and shot. One of the specimens was forwarded to the Bureau of Biological Survey, Washington, where the above determination was confirmed by A. H. Howell. I do not find a previously recorded occurrence of this species for California.

Pipistrellus hesperus hesperus (H. Allen)

Cañon Bat

The most abundant representative of the order Chiroptera observed during the period of our work. Seen abroad at dusk as early in the season as February 23, when the nights were still so cold that ice formed in suitable places. Numerous at Mellen, February 23 to 28, and swarming in the vicinity of The Needles March 1 to 3. Thenceforth seen at nearly every station all the way down the river. One thing was conspicuously noticeable in regard to occurrence, namely, that this bat varied directly in degree of abundance with nearness to cliffs, or hillsides with outcroppings of fractured rock. In other words, this species probably dwelt exclusively in the rocks during the day, from which it emerged at early dusk to forage out over the river bottom in the near vicinity.

Individuals were often seen before the sunlight had yet left the eastern hilltops. On one occasion, as we were floating down the river near Picacho, a *Pipistrellus* appeared in flight in the glaring forenoon sunshine, dipped down to the surface of the water, where it touched, and thence flitted back to a crevice in the nearby cliff.

Seventy-four specimens of this species were shot (nos. 10382–10423, 10746–10777), 42 being preserved as skins and 32 as alcoholics. Eighteen out of this series are from the California side of the river near Pilot Knob, only about six miles due west of old Fort Yuma, and are thus practically topotypes of *Pipistrellus hesperus*.

In reviewing the Museum's entire collection of *Pipistrellus* from California, it becomes clearly apparent that while there is but one species represented, there are two appreciably different subspecies of this species, one a pale-colored form occupying the arid desert regions from Owens Valley and the vicinity of Walker Pass southeast to the Mexican line, the other a darker-colored form occurring on the Pacific slope of southern California (in the San Diegan district) and in certain parts of the San Joaquin and Sacramento valleys.

It appears to the writer that we have here two races well worthy of recognition in nomenclature. The name *hesperus* was based on the desert form. A name is apparently available for the Pacific race in the *Vesperugo merriami* of Dobson (1886, p. 124). This has always been synonymized under *Pipistrellus hesperus*. While the habitat is given by Dobson as "North America (Locust Grove, State of New York)", an error was committed, for the type really came from Red Bluff, Tehama County, California (*fide* Miller, 1897, p. 31). Dobson

received his specimen from C. H. Merriam, whose residence at that time was Locust Grove, New York.

The case seems to be clear, and I propose that the Pacific slope race be called *Pipistrellus hesperus merriami* (Dobson), the type locality of which is thus Red Bluff, California. The characters of this form, as compared with *P. h. hesperus*, lie in the darker, distinctly browner tone of coloration both above and below, and in somewhat larger size throughout. The Museum has specimens, unequivocally of this form, from the following localities, all within the state of California: Marysville Buttes, Sutter County; Raymond, Madera County; Cuyama Valley, Santa Barbara County; Fort Tejon, Kern County; San Francisquito Cañon, northern Los Angeles County; vicinity of Pasadena; Escondido, San Diego County.

Eptesicus fuscus (Beauvois)

Large Brown Bat

One shot at dusk on the California side near Pilot Knob, May 6. Other bats supposed to be the same species were seen flying down the river high overhead the same evening. A strong west wind was blowing at the time. The species was not seen at any other place.

The specimen secured (no. 10697) is an adult female. It appears to differ in small size and extreme paleness from the average of the species from California. It about equals in the latter respect the palest out of a series of ninety brown bats from the Pacific slope of California. The color dorsally is uniform isabella color, ventrally pale wood brown. Measurements: length 107 mm., tail vertebrae 44, foot 9, forearm 42.5, longest finger 72, ear (dry) 12. The skull, too, is appreciably small.

A general inspection of the Museum's series of this species from California points towards the existence within the state of at least three geographic races based on size and depth of color. But so much of the total area is unrepresented by specimens that systematic analysis at this time seems inadvisable.

Nyctinomus mexicanus Saussure

Mexican Free-tailed Bat

We were fairly certain of seeing this bat at almost every station, as a rule flying high and often squeaking loudly. Only three specimens were secured (nos. 10690–10692) the first two at Mellen, February 26, the third in Chemehuevis Valley, March 11.

Macrotus californicus Baird

California Leaf-nosed Bat

One of the rooms of an adobe ruin on the Arizona side, ten miles below Cibola, showed considerable bat excrement on the floor. No bats could be found in the thatch above, so the place was visited in the evening. No bats appeared in the vicinity until all daylight had faded. Then two were seen flying about the ruins; and by means of a lantern and butterfly net, one was caught in the room referred to. This was probably used by the bats merely to repair to while eating the moths caught outside; wings of the latter were strewn upon the floor.

The specimen obtained (no. 10693) is an adult male; the date April 8.

Transmitted June 13, 1913.

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PLATE 3

Map of Needles-to-Yuma portion of lower Colorado River, showing stations from which collecting was carried on by the 1910 expedition from the California Museum of Vertebrate Zoology. (See itinerary, pp. 53–57.)

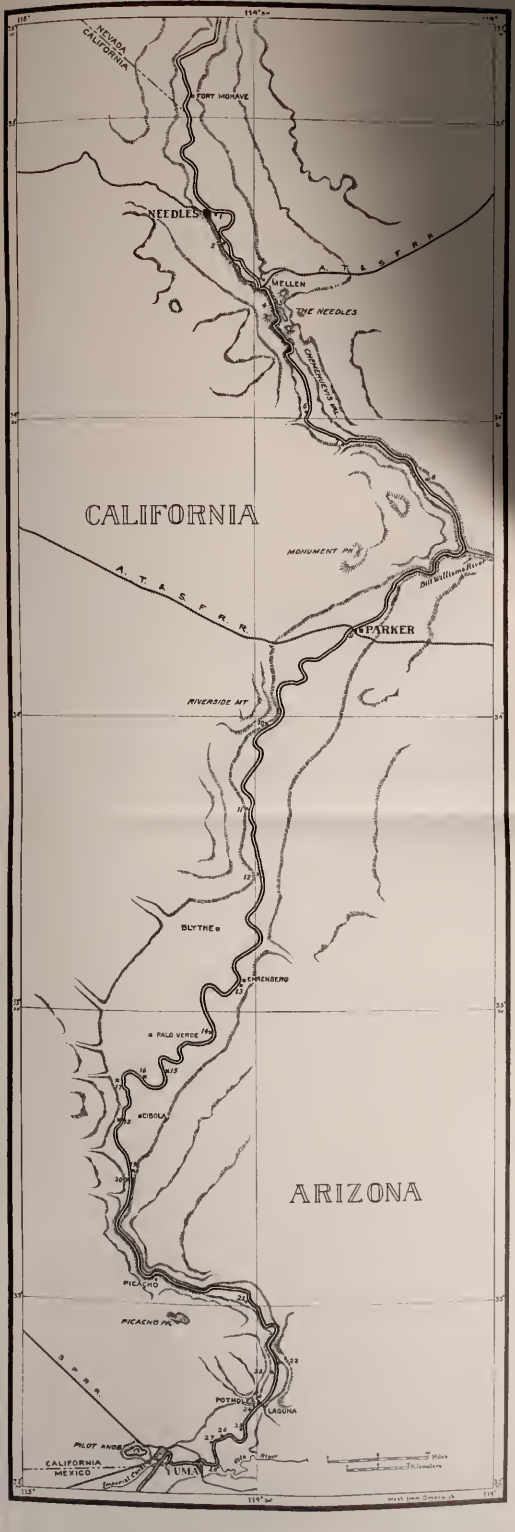
NEVADA
CALIFORNIA
FORT MOHAVE
NEEDLES
MELLEN
THE NEEDLES
A. T. & S. F. R.
CALIFORNIA
MONUMENT PK.
Bill Williams River
PARKER
RIVERSIDE MT.
BLYTHE
EARENBERG
PALO VERDE
CIBOLA
ARIZONA
PICACHO
PICACHO PK.
S. P. R.R.
POTHOLES
LAGUNA
PILOT KNOB
CALIFORNIA
MEXICO
YUMA
Miles
Kilometers

PLATE 4

Fig. 2. Looking up the Colorado River from Mellen, Arizona. At this date, February 27, 1910, the river was at a low stage, leaving many mud bars uncovered. These bars were resorted to as forage grounds by herons and ravens.

Fig. 3. California shore near Pilot Knob, showing dense mass of cane (*Phragmites communis*), partly submerged, and in part hanging over the bank into the water. The log held fast by the tangle of cane was the favorite resort of muskrats (*Ondatra zibethica pallida*), two of these animals being caught at this particular place. This cane is a conspicuous riparian element on permanent banks from the vicinity of Picacho to the Mexican line. Resident birds showing marked preference for these cane thickets were *Melospiza melodia saltonis* and *Geothlypis trichas scirpicola*. Photograph taken May 15, 1910.

Fig. 2

Fig. 3

PLATE 5

Fig. 4. Looking north over the flood plain of the Chemehuevis Valley, California side. At this date (March 10, 1910) only the cottonwoods had come into leaf. This is the typical willow-cottonwood association of the riparian belt as found in all the broad valleys. The component plants are willows, of two species, cottonwood, guatemote, and screw bean. Some of the latter show in the foreground because of the mistletoe clumps in their as yet leafless branches. At the time of taking this picture birds of the winter visitant category were plentiful (see text, p. 71).

Fig. 5. The arrow-weed association, the typical element in which is the arrow-weed (*Pluchea sericea*). This plant forms an almost continuous growth over the river flood plain outwardly adjacent to the willow-cottonwood association. Animal life was poorly represented in this association as compared with any other of the region. Those birds and mammals found therein appeared nearly all to traverse it only incidentally, in passing between the mesquite and willow associations. Photograph taken near Pilot Knob, May 11, 1910.

Fig. 4

Fig. 5

PLATE 6

Fig. 6. Portions of quail-brush (in foreground) and mesquite associations, paralleling each other and situated next outwardly from the arrow-weed association. Photograph taken on the Arizona side about one mile above Mellen, February 27, 1910. On this date the deciduous mesquites were still leafless, the dark patches being masses of the mistletoe (*Phoradendron californicum*). The latter parasitic plant produces an almost perennial and abundant crop of berries which form a staple food supply for many species of birds, notably the phainopepla, western bluebird, western robin, and mockingbird. The quail-brush (*Atriplex lentiformis*), because of its stoutly interlacing and spiny branches, forms an ideal refuge for such animals as the cottontail rabbit and desert quail. Abert towhees are permanent inhabitants of this belt as well as of the adjacent one on each side, while the winter-visiting Zonotrichias make it their headquarters.

Fig. 7. Mesquite (*Prosopis juliflora*) in full leaf and fruit, the latter the bean-like pods. The mesquite marks a distinct association, the outermost one of the riparian set of associations. Both the foliage and the fruit constitute important food sources for many of the animals of the region, either directly or indirectly. Among birds, characteristic permanent residents are the crissal thrasher and Abert towhee. The Colorado river wood rat (*Neotoma albigula venusta*) is a characteristic mammal. Photograph taken near Pilot Knob, May 11, 1910.

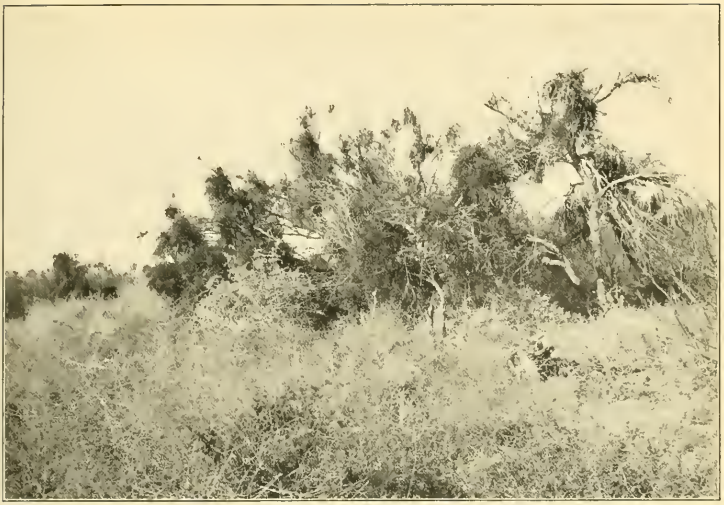

Fig. 6

Fig. 7

PLATE 7

Fig. 8. The salt-bush association, on second-bottom above the reach of the highest overflow. The large plant in the center of the picture is the creosote bush (*Larrea divaricata*) which in places invades the second bottom nearly or quite to the edge of the mesquite and grows to larger size in such places than on the desert mesa. The prevailing low, light-colored shrub, is the salt-bush (*Atriplex polycarpa*). Winter visiting birds of this association were: Nevada sage sparrow, Brewer sparrow and desert Bewick wren; mammals caught at this point were *Dipodomys merriami* and *Perognathus penicillatus*. Photograph taken one mile above Mellen, Arizona, February 27, 1910.

Fig. 9. Typical wash association, the catclaw (*Acacia greggii*) being the plant most constantly present. Thickets of catclaw are to be seen in the right foreground, while large ironwood and palo verde trees are to be seen in the middle distance. The distant hill slopes are dotted with creosote bushes, while *Atriplex polycarpa* margins the wash in the immediate foreground. Resident birds of this wash association were: verdin, plumbeous gnatcatcher, and cactus wren. Photograph taken March 10, 1910, on California side, near lower end of Chemehuevis Valley.

Fig. 8

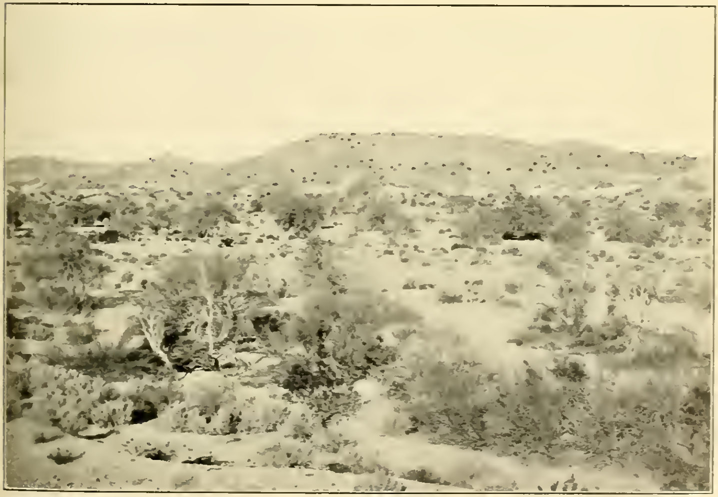

Fig. 9

PLATE 8

Fig. 10. Ironwood tree (*Olneya tesota*) photographed March 10, 1910, in the wash pictured in the previous plate. This individual, an unusually large one, was 90 inches in circumference of trunk two feet above the ground, 31 feet in extreme height, and with a foliage expanse of 50 feet. The thorny branches afforded protection to several nests, old and new, of the verdin. The blossoms of this plant, which appear in May, attract numerous hummingbirds.

Fig. 11. Palo verde tree (*Parkinsonia torreyana*) of unusual size. At the time of blossoming, in April, this tree is resorted to by many migrating birds, both for the flower nectar and the insects. Like other elements in the wash association the palo verde is frequented by verdins, plumbeous gnatcatchers and cactus wrens. Photograph taken February 27, 1910, on the Arizona side above Mellen, near the mouth of the Sacramento wash.

Fig. 10

Fig. 11

PLATE 9

Fig. 12. Giant cactus (*Cereus giganteus*) on California side four miles north of Potholes. A palo verde stands immediately beyond, its trunk being nearly hidden by that of the cactus. The extreme height of the latter was 28 feet. Openings may be seen in the upper branches. Two of these were inhabited by a pair each, respectively, of the Gila woodpecker and ash-throated flycatcher. Photograph taken April 23, 1910.

Fig. 13. Giant cactus on California side four miles above Potholes, photographed April 23, 1910. In a hole in this cactus was found a brood of gilded flickers (just beneath short left-hand branch), and three feet higher up in a cavity opening on the opposite side of the trunk was a saguaro screech owl.

Fig. 12

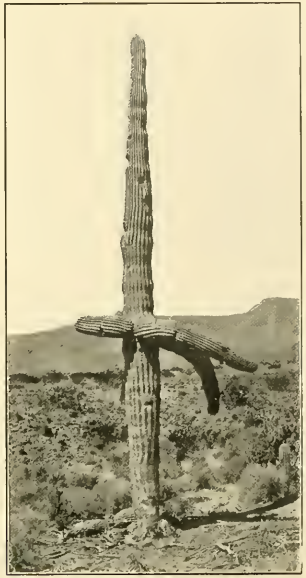

Fig. 13

PLATE 10

Fig. 14. Looking due south from Mellen, Arizona, and toward the group of spire-pointed hills known as "The Needles." The Colorado River in the right distance. Typical rocky mesa in the immediate foreground, the scattering plants being creosote bushes. The desert mesa is here seen to abut closely upon the river, leaving only very narrow riparian strips. Mammals trapped on the mesa at this point were *Perognathus intermedius* and *Ammospermophilus harrisi*. Photograph taken February 28, 1910.

Fig. 15. Photograph taken March 7, 1910, on the Arizona side, from upper slope of The Needles. Channel of the Colorado River at extreme left. The chief vegetation on the steep rocky slopes is the creosote bush and *Encelia farinosa*. The latter reappears so persistently upon such ground that its name has been selected to apply to the association marked by its presence. Mammals trapped on this slope were *Neotoma intermedia desertorum, Perognathus intermedius* and *Ammospermophilus harrisi*.

Fig. 14

Fig. 15

PLATE 11

Fig. 16. Group of burrows of the large kangaroo rat (*Dipodomys deserti*). Tracks of the animals may be seen in the soft aeolian sand, here accumulated to considerable depth. The dessicated remains of a brief-lived annual vegetation may be seen on the sand between the creosote and the salt-bushes. Other species of mammals trapped in this, a variation of the salt-bush association, were: *Citellus tereticaudus, Peromyscus eremicus,* and *Perognathus penicillatus.* Photograph taken about one mile north of Mellen, Arizona, February 27, 1910.

Fig. 17. Mouth of burrow of the large kangaroo rat (*Dipodomys deserti*), showing parallel imprints of the hind feet and the tail in the soft sand. Photograph taken above Mellen, Arizona, February 27, 1910.

Fig. 16

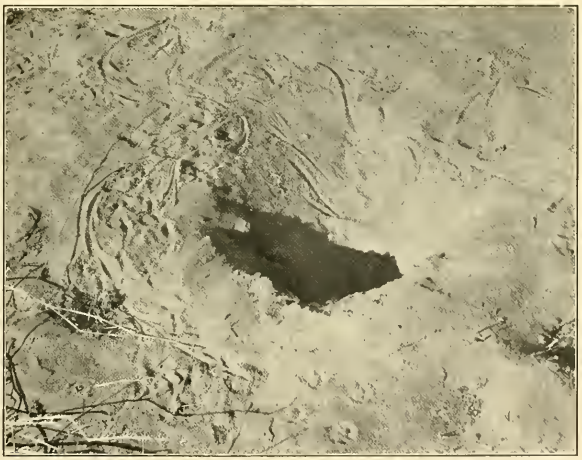

Fig. 17

PLATE 12

Fig. 18. Burrow of the Harris ground squirrel (*Ammospermophilus harrisi*) beneath creosote bush on desert mesa near Mellen, Arizona. The wind-worn pebbles of the mesa surface are here well shown, the loose sand being continually removed by the prevailing winds. Photograph taken February 28, 1910.

Fig. 19. Ironwood tree almost completely killed by the rising of the water level in the soil at the outer edge of second bottom. A nest of the Lucy warbler (*Vermivora luciae*) was situated 35 inches from the ground in a cavity in the side of the trunk. Photograph taken April 12, 1910, near the Draper ranch, on the California side eighteen miles north of Picacho.

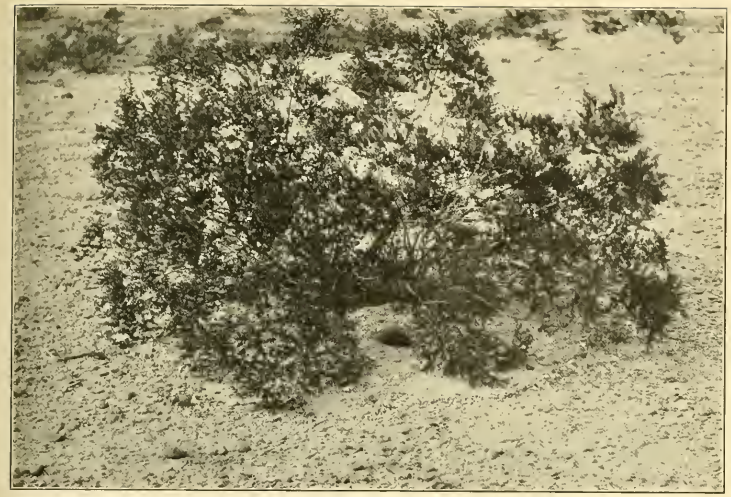

Fig. 18

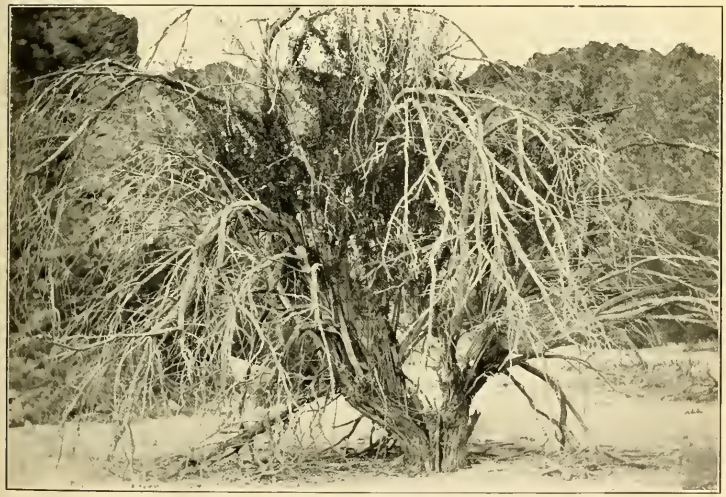

Fig. 19

PLATE 13

Fig. 20. Nest of the Lucy warbler (*Vermivora luciae*) in crevice on side of trunk of partly dead ironwood shown in plate 12, figure 19. This nest contained three eggs. Photographed April 12, 1910, on the California side, eighteen miles above Picacho.

Fig. 21. Selected specimens of *Mephitis estor* from the Colorado Valley: at left, no. 10575, Chemehuevis Valley, California side; middle, no. 10574, five miles south of Needles, California side; at right, no. 10579, twenty miles above Picacho, California side. The variation shown is individual. If the contrasted black and white markings are of warning significance, hence of adaptive advantage to the species, why should the desert skunks have proportionally much more white than skunks from the humid northwest coast belt of the United States? (See text, p. 256.)

Fig. 20

Fig. 21

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APLODONTIA CHRYSEOLA, A NEW MOUNTAIN BEAVER FROM THE TRINITY REGION OF NORTHERN CALIFORNIA

BY
LOUISE KELLOGG

A PREVIOUSLY UNDESCRIBED *APLODONTIA* FROM THE MIDDLE NORTH COAST OF CALIFORNIA

BY
WALTER P. TAYLOR

UNIVERSITY OF CALIFORNIA PRESS
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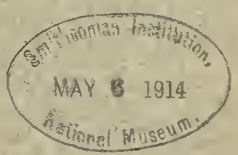

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APLODONTIA CHRYSEOLA, A NEW MOUNTAIN BEAVER FROM THE TRINITY REGION OF NORTHERN CALIFORNIA

BY
LOUISE KELLOGG
(Contribution from the Museum of Vertebrate Zoology of the University of California)

Discovery of the well-marked new form of mountain beaver here described was one of the results of field work carried on in the Trinity region of northern California by Miss Annie M. Alexander and the writer during the summer of 1911.

Aplodontia chryseola, new species

Trinity Mountain Beaver

TYPE: Male adult, no. 13328, Mus. Vert. Zool.; Jackson Lake, Siskiyou County, California, altitude 5900 feet; June 22, 1911; collected by A. M. Alexander; original number 1441.

SPECIFIC CHARACTERS: Coloration, both above and below, varying about ochraceous-buff or buffy golden; rostrum short as compared with that of *Aplodontia californica* (Peters); auditory tubes long in proportion to size of skull.

MATERIAL: The basis for this diagnosis consists of nine specimens, nos. 13324–13332, taken at the following localities, all in that portion of the Trinity Mountain region known as the Salmon Mountains: Jackson Lake; South Fork of Salmon River; Wildcat Creek; head of Grizzly Creek.

REMARKS: In size this new species of *Aplodontia* is nearest *A. californica* (Peters) (= *A. major* Merriam), the form occupying the

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Sierra Nevada Mountains, but it differs materially from the latter both in certain cranial characters and in its golden coloration. In the latter respect, however, it closely resembles the small *Aplodontia phaea* Merriam, found in Marin County, California. Specimens taken on the slopes of Mount Shasta seem to be typical of *A. californica*, showing no gradation towards *A. chryscola*.

The general coloration of *Aplodontia chryscola*, on the back, is fulvous or ochraceous, thickly sprinkled with black. The dense underfur is black at the base in fresh pelage, wearing to slate, and tipped with ochraceous-buff. The long hair is a mixture of gleaming ochraceous-buff and black, giving a peculiar bright effect, of gold and black. The sides are ochraceous-buff with fewer black hairs. The underparts are plumbeous, wearing to lighter gray, and heavily sprinkled with ochraceous-buff, especially around the throat and cheeks. The tip of the nose is seal brown, face drab, whiskers mainly white.

A further discussion of the Trinity mountain beaver, as well as an account of its habits, is contained in the writer's paper on the mammals of the Trinity Mountain region now in preparation. In order to facilitate further work on the Aplodontiidae, in progress both in the Department of Palaeontology and in the Museum of Vertebrate Zoology, of the University of California, immediate publication of this description is deemed advisable.

Transmitted January 24, 1914.

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A PREVIOUSLY UNDESCRIBED *APLODONTIA* FROM THE MIDDLE NORTH COAST OF CALIFORNIA

BY
WALTER P. TAYLOR
(Contribution from the Museum of Vertebrate Zoology of the University of California)

The recent discovery by field parties working in the interests of the California Museum of Vertebrate Zoology, of two new forms of *Aplodontia*, is a testimony both to the restricted habitats of the animals in this genus and to the incompleteness of our knowledge of even so small and well-worked an area as the State of California. Additional attention is directed to these points by the fact that one of the new forms is the most strikingly marked species yet found within the state.

Material in the collection of the Museum indicates the existence in the vicinity of Humboldt Bay, California, of a third distinct new form, most closely related to *Aplodontia chryseola* Kellogg, of the Trinity Mountains. The status of this form cannot certainly be determined, however, without more specimens.

Aplodontia nigra, new species

Point Arena Mountain Beaver

TYPE: Male adult, no. 20320, Mus. Vert. Zool.; Point Arena, Mendocino County, California; July 10, 1913; collected by C. L. Camp; original number 1003.

DIAGNOSTIC CHARACTERS: Most closely related to *Aplodontia phaea* Merriam, but nasal outline swelling at the sides anteriorly, the broadest portion of the nasals tending to be just posterior to their anterior

ends, contrary to the condition in *phaca;* nasals uniformly broader than in *phaca;* interpterygoid fossa broader. Coloration dorsally shiny black instead of ochraceous-buff; ventrally warm buff instead of ochraceous-buff or light ochraceous-buff (Ridgway's *Color Standards and Nomenclature*, 1912, used as color guide).

Material: Twenty specimens of *Aplodontia phaca;* four specimens of *Aplodontia nigra.* It should be noted that both series, with the exception of two specimens of *A. phaca* (nos. 8973, 8974), were taken during the summer season, so are strictly comparable as to pelage.

Descriptive Remarks: *Coloration.*—The black-and-gray dorsal appearance of *Aplodontia nigra* is unique among known California aplodonts. This character marks the new species off sharply from *A. phaca*, to which its size and cranial characters show it to be most closely related. The prevailing color tone seen in a dorsal view is, in *nigra*, shiny black; in *phaca*, ochraceous-buff. The dorsal coloration is modified somewhat in *nigra* by the dark plumbeous bases of the hairs showing through. Some of the dorsal hairs are tipped with buffy. These are so few, however, that the general dorsal aspect is shiny black only faintly sprinkled with grayish. In *phaca*, the ochraceous-buff of the dorsal surface varies toward light ochraceous-buff. The general coloration is modified by the showing through of the dark plumbeous bases of the hairs and also by the admixture of numerous black hairs. There is also a sprinkling of hairs tipped with light buff. The result of the mixture of these variously marked hairs is a grizzled ochraceous-buff appearance.

Face in *A. nigra* is dark quaker drab; near pale quaker drab in *A. phaca.*

Sides paler than back in *A. nigra*, there being fewer black hairs, and more buffy-tipped ones. In *A. phaca* the sides are nearly the same as the back, grading into the coloration of the underparts.

There is much more blackish externally on both fore and hind feet in *A. nigra*, as well as on the rump and tail. In *A. phaca* these parts tend to be browner. The feet in *A. nigra* are blackish, in *phaca* brownish.

A. nigra has basal portions of hairs ventrally varying between plumbeous, deep plumbeous, and dark plumbeous, and upper portions of the same hairs warm buff. *Phaca* has hairs ventrally a paler shade on their basal portions, varying between plumbeous and cinereous, and their outer portions ochraceous-buff or light ochraceous-buff.

Coloration is remarkably uniform in the series of *phaca*, showing only a very narrow range of individual variation. Of the four specimens of *nigra*, three are young. In coloration these differ only slightly from the adult, and present the diagnostic characters of the species as clearly.

It should, perhaps, be emphasized that coloration serves unquestionably to differentiate *A. nigra* from any other species of the same genus found in California.

Cranial characters.—See table of measurements, following. Only one specimen of *Aplodontia nigra* (no. 20320) is strictly comparable with the series of four adult male specimens of *Aplodontia phaca* listed in the table. The three other specimens show the open sutures and immature characteristics of youth.

Three characters stand out as specifically distinctive: the width of the interpterygoid fossa, and the outline and breadth of the nasal bones. *A. nigra* (no. 20320) has the interpterygoid fossa thirty per cent broader than it is in the average of *phaca*, at least as shown in the table of measurements.

The outline of the nasals is different. *A. nigra* has this outline dilated anteriorly, the broadest part of the nasals being about six millimeters posterior to their anterior ends. In *phaca* the tendency is for the broadest part of the nasals to be at the anterior points at which nasals and premaxillae join. *A. nigra*, no. 20321, approximates the condition in *phaca*, while *A. phaca*, no. 20309, tends toward the relation in *nigra*. The breadth of the nasals is definitely greater in the Point Arena form than in *phaca*, however, the youngest specimen of the former exceeding in this respect all the adult males of the latter measured.

In other cranial characters *A. nigra* is nearly identical with *A. phaca*, clearly exhibiting the comparatively close relationship of the two coast forms.

The Point Arena *Aplodontia* may be separated from any other species represented in our collections on the basis of cranial as well as external characters. Perhaps the most convenient is the length of the incisive foramen, which is less in the crania of the two coast forms than in comparable specimens of *A. rufa*, or in the species heretofore described from California. Size also is a differentiative characteristic when *nigra* is compared with *rufa* or with Californian species.

It is perhaps worthy of note that the smallest, darkest forms of *Aplodontia* are found along the western coast of the United States.

Aplodontia pacifica Merriam, described from Newport, mouth of Yaquina Bay, Oregon, is the darkest species of mountain beaver known heretofore, and is the smallest species as yet characterized.

Transmitted January 22, 1914.

Table of Cranial Measurements of *Aplodontia phaea* and *A. nigra*
All measurements in millimeters

	Length of nasals[1]	Width of nasals[2]	Ratio, width of nasals to length	Length of incisive foramina[3]	Greatest breadth of interpterygoid fossa[4]	Length of auditory tubes[5]	Basilar length	Ratio length of auditory tubes to basilar length
Aplodontia phaea								
20309 ♂ 6 mi. W. Inverness, Marin Co., Calif...	23.6	9.8	41.5	7.3	4.2	15.8	59.0	26.8
8974 ♂ Lagunitas, Marin Co., Calif.	.....	9.9	.....	6.2	4.6	15.3	55.4	27.6
20311 ♀ 6 mi. W. Inverness, Marin Co., Calif...	22.1	9.8	44.3	6.5	4.4	16.0	56.9	28.1
20305 ♀ 6 mi. W. Inverness, Marin Co., Calif...	21.8	9.8	45.0	6.5	4.1	17.3	58.5	29.6
Aplodontia nigra								
20320 ♂ Point Arena, Mendocino Co., Calif...	23.5	11.0	46.8	6.8	5.6	17.5	56.9	30.8
20321 ♂ Point Arena, Mendocino Co., Calif...	21.9	10.0	45.6	5.5	4.8	15.4	52.9	29.1
20319 ♂ Point Arena, Mendocino Co., Calif...	22.2	10.9	49.1	5.0	4.9	15.3	55.0	27.8
20318 ♂ Point Arena, Mendocino Co., Calif...	22.7	10.5	46.2	5.2	5.7	14.5	52.9	27.4

[1] Most anterior point on nasal bones to most posterior point.

[2] Greatest width of nasals, across both of them.

[3] With cranium resting on its dorsal surface, rostrum pointing away from the worker, the greatest length of the foramen on the right side.

[4] Taken at expansion of interpterygoid fossa immediately back of hard palate.

[5] Most lateral point on foramen ovale to the point farthest laterally (with reference to the skull) on zygomatic side of auditory tube.

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BY
JOSEPH GRINNELL

Smithsonian Institution
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A SECOND SPECIES OF THE MAMMALIAN GENUS *MICRODIPODOPS* FROM CALIFORNIA

BY
JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The remarkable rodent genus *Microdipodops* came to the attention of naturalists only about twenty-three years ago. So far as at present known, it occupies a more restricted area than any other genus of Sonoran mammal, namely, the central and northern parts of Nevada, and the adjacent extreme southeastern portion of Oregon and eastern edge of California. This genus may thus be inferred to be an essentially Great Basin product. Even within this limited region geographic speciation is strongly in evidence, so that four species have already been distinguished by name. The existence of any representative of the genus within the state of California was first discovered by Dr. Walter K. Fisher, who, in August, 1900, sent to the United States Biological Survey some specimens obtained by him in Sierra Valley, Plumas County, near the town of Vinton. One of these specimens became the type of *Microdipodops californicus* C. H. Merriam (1901, p. 128). This has continued until the present time the only record of the occurrence of the genus in California.

In July, 1912, two collectors from the California Museum of Vertebrate Zoology, Messrs. Chas. D. Holliger and Norman Stern, trapped for mammals in the vicinity of Benton, Mono County, California. As one result of their work there, *Microdipodops* was found to be rather commonly represented, and a series of ten specimens (nos. 17031-17040) was secured. These prove to represent a species altogether distinct from *M. californicus*, and also different from the other three species of the genus characterized to date.

Smithsonian Institution
MAY 6 1914
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The previously described forms of *Microdipodops* are: *M. megacephalus* (C. H. Merriam, 1891, p. 116), type locality Halleck, Elko County, Nevada; *M. megacephalus oregonus* (C. H. Merriam, 1901, p. 127), type locality Alvord Desert, Harney County, Oregon; *M. pallidus* (C. H. Merriam, 1901, p. 127), type locality Carson Sink, near Stillwater, Churchill County, Nevada; *M. californicus* (C. H. Merriam, 1901, p. 128), type locality Sierra Valley, near Vinton, Plumas County, California.

Microdipodops polionotus, new species

Mono Kangaroo Mouse

Type.—Male adult, no. 17031, Mus. Vert. Zool.; McKeever's Ranch, two miles south of Benton Station, Mono County, California, altitude 5200 feet; July 10, 1912. Collected by C. D. Holliger; orig. no. 184.

Diagnostic Characters.—Nearest like *Microdipodops pallidus* in general appearance, but coloration paler, decidedly more ashy in tone, and white areas emphasized in brilliancy; pelage notably shorter, less lax and fluffy; general size less, and tail decidedly shorter; skull similar to that in *pallidus* and *megacephalus*, but auditory capsules slightly less inflated, particularly less protuberant behind.

Coloration of Type.—Above, cartridge buff (of Ridgway's *Color Standards and Color Nomenclature*, 1912), with the hairs minutely black-tipped especially on the rump; sides of face and rump least buffy, presenting a distinctly ashy tone; underfur a pale tint of gray, number 7; dorsal side of tail cartridge buff proximally, becoming gradually dusky-hued towards tip; lower surface of tail and feet, white; whole lower surface of body brilliant white, abruptly contrasted with dorsal color along sides; some of whiskers black, and others, the longer posterior ones, white; ears like back in tint, but with a silvery white upper rim, a conspicuous snowy white spot at inferior base, and an even larger white patch just behind.

Measurements.—Of type, total length 145 millimeters, tail vertebrae 80, hind foot 24, ear from crown 9; average of seven adults, total length 148, tail vertebrae 82, hind foot 23.7, ear from crown 7.6.

Comparative Remarks.—The new species differs from all those previously described in extreme pallor of coloration. The contrast with *californicus* is particularly great, the dorsal color in that form being strongly brownish, approaching tawny-olive in fused tone. *Polionotus*

is ashy gray, very faintly tinged with buff. This tone of coloration, on the insides of the ears alone, serves to characterize every individual in our series of *polionotus*. The white around the ears is particularly conspicuous as compared with that in all the forms except *californicus*, in which species the darker surrounding color makes up for the lesser amount of white in producing the effect of contrast.

There is a notable difference in quantity and texture of pelage among the different species. It is possible that some of the variation in this respect is due to season, but it cannot all be. Our skins of *polionotus*, taken in July, exhibit much longer pelage than is shown by specimens of *californicus* taken in August, and yet not so long and especially not so silky and lax as shown by examples of *pallidus* taken in May.

The body size of all the species appears to be about the same, but there is some variation in tail length. *Polionotus* has a lesser tail length than *pallidus* as given by Merriam, resembling most nearly *megacephalus* in this particular.

The skulls of *megacephalus* and *pallidus* are essentially alike according to Merriam. The skulls of *polionotus* differ from examples at hand of those just named, in noticeably smaller auditory capsules. The inflation is decidedly less, so that when looked at from behind the skulls of *polionotus* do not stand so high, due to less inflation of bullae; when looked at from above the mastoid inflation is seen to be less protuberant both laterally and behind; the notch between the bulging capsules behind is thus not so deep. The rostra are not of the relatively slender build shown in *californicus*.

Habitat.—The entire series of *Microdipodops polionotus* was obtained on a sandy, sagebrush flat, on the McKeever Ranch, two miles south of the railroad station of Benton, Mono County, California. The altitude of this flat is close to 5200 feet, and in common with the rest of the immediately adjacent region the type locality lies in an extremely arid faunal division of the Upper Sonoran Zone. The dates of capture are July 10, 11, and 12. Three of the animals are obviously young, one of these being not over half grown.

Acknowledgments.—The present study was put upon a satisfactory basis through the privilege accorded the writer by Mr. Henry W. Henshaw, Chief of the Bureau of Biological Survey, Washington, of examining specimens contained in the portion of the National collection under his charge. This borrowed material consisted of skins-with-skulls of each of the four previously described forms, as follows:

Microdipodops megacephalus, five topotypes; *M. m. oregonus*, two topotypes; *M. pallidus*, two specimens from the general type area; *M. californicus*, five topotypes.

Transmitted February 11, 1914.

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WITH DESCRIPTION OF A NEW SUBSPECIES

BY
JOSEPH GRINNELL

Smithsonian Institution
NOV 12 1914

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WITH DESCRIPTION OF A NEW SUBSPECIES

BY

JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

River otters (genus *Lutra*) are still known to occur at irregular intervals in the streams of northern and central California. The southernmost ascertained point of occurrence in the coast belt is a creek flowing into one of the heads of Drake Bay, near Point Reyes, Marin County. In the great Sacramento–San Joaquin Valley there are definite reports of otters from various streams and sloughs south as far as near Lane Bridge, north of Fresno, in that portion of the San Joaquin River forming the boundary between Fresno and Madera counties. There are rumors of occurrence still farther south, namely in certain streams making down from the high southern Sierra Nevada; but there is as yet no acceptably authenticated instance. There are no records at hand from the coast belt south of San Francisco Bay and none from the San Diegan district.

Otters are stated to be "occasionally caught in the Colorado River," along the southeastern border of California (Stephens, 1906, p. 234). The writer just cited refers to the Colorado River animal under the name *Lutra canadensis sonora* Rhoads, apparently assuming its identity with the form described from a tributary of the Gila River, in Yavapai County, Arizona. This assumption is probably correct, and the form *sonora* should not have been omitted, as it was, from my distributional list of the mammals of California (Grinnell, 1913, p. 297). However, I am unable at this time to add any corroborative

evidence either as to the occurrence of otters in the Colorado River, or as to the status of the form there represented. It is practically certain that decided differences exist between the race occurring to the west beyond the broad expanse of waterless desert and that of the Colorado basin. Rhoads' description of *sonora* comes near to providing clear proof of this, although he had evidently not had the opportunity to make comparisons with the Californian animal. Unfortunately, the present writer has no specimens of *sonora* for examination

Returning again to the river otter of central and northern California, there are in the California Museum of Vertebrate Zoology seven specimens from this area, as follows: one (no. 4975), skin only, from John's Camp, McCloud River, Shasta County, secured by E. L. Furlong; one, skull only (no. 12653), from Price Creek, tributary to Eel River, Humboldt County, obtained by F. Stephens; two, skulls only (nos. 19153, 19154), and two, skins with skulls (nos. 19098, 19152), from Cuddeback, on tributary of the Eel River, Humboldt County, all taken by H. E. Wilder; and one, skin with complete skeleton (no. 20775), from Grizzly Island, Solano County, secured by Miss A. M. Alexander. In studying this Californian material the writer has had access to twenty-one other specimens from Alaska, two from Queen Charlotte Islands, British Columbia, one from Vancouver Island, British Columbia, and two from Klamath County, Oregon, all this material being also contained in this Museum; and three additional skulls from Oregon, two from McKenzie River, Lane County, and one from Bend, Crook County, kindly loaned the writer from the Oregon State Fish and Game Office by Mr. Stanley G. Jewett.

It is believed that the above specified material, in conjunction with the published measurements, plates, and descriptions by Rhoads (1898, pp. 423–439, pls. 24, 25) suffices for determining the systematic status of the California river otter. After an appropriate examination of the facts in the case I am led to conclude that we have here an additional distinct subspecies, which requires naming.

Lutra canadensis brevipilosus, subsp. nov.

California River Otter

Type.—Female adult, skin and complete skeleton, no. 20775, Mus. Vert. Zool.; Grizzly Island, Solano County, California; January 26, 1914; secured from a local trapper by Miss Annie M. Alexander, and presented by her to the Museum.

Diagnostic Characters.—Similar to *L. c. pacifica* and *L. c. periclyzomae*, but general size greater, pelage shorter, coloration paler, and proportions of skull different, the cranium for one thing being narrower and higher.

Description of Type.—Weight before skinning, 16 pounds, 10 ounces. Total length, 1158 millimeters; caudal vertebrae, 447; hind foot, 123.5; height of ear from crown, 20; ear from noteh, 23.8. Length of hair: on middle of back, 21; top of head between ears, 11; top of tail along median line half-way toward tip, 20.5; middle of belly, 16.4. Length of fur: on middle of back, 13.8; top of head, 8.1; top of tail, 9; belly, 9.8. Coloration (nomenclature, that of Ridgway's *Color Standards*, 1912): above bister, with hairs distinctly paler tipped, giving a grizzled effect, gradually paling around sides to Saccardo's umber on lower surface of body and tail; this further paling anteriorly to avellaneous on throat and to tilleul-buff on chin and upper lip; tops of fore and hind feet snuff brown; whiskers chiefly whitish. Skull small (see table of measurements); rostral portion relatively both narrow and shallow; braincase narrow and high: ratio of height of skull at bulla to mastoid breadth 64 per cent; dentition light.

Remarks.—Lutra c. pacifica Rhoads (1898, p. 429), type from Lake Keechelus, Kittitas County, Washington, is evidently a large race, very similar to *L. c. periclyzomae* Elliot (1905, p. 80), type from Queen Charlotte Islands, British Columbia. The differences between these two must be very slight. In fact Heller (1909, p. 262), after examining good series in the national collections at Washington, was able to find but one "reliable character" to distinguish *periclyzomae* from *pacifica*, namely "the extreme flatness of the audital bullae." The bullae of *brevipilosus* are much smaller, but relatively somewhat more elevated, than in British Columbian examples of *periclyzomae*.

The type of *brevipilosus* is extreme in all skull characters (see pl. 14), so that it probably represents the farthest southern divergence of the Pacific Coast series of forms. The Humboldt County specimens are very similar, as shown in the table of measurements herewith given of Californian skulls. The five Oregon skulls are somewhat intermediate towards the *pacifica-periclyzomae* style; but because of their small size I should apply the name *brevipilosus* to them, along with all the Californian specimens. Characters of pelage and color are likely to prove intermediate also, though this surmise is practically worthless in absence of skins from Oregon and Washington. The three

List and Measurements in Millimeters of Skulls of *Lutra canadensis brevipilosus* from California

Mus. No.	Sex Age	Locality	Basilar length of Hensel	Condylo-basal length	Zygomatic breadth	Mastoid breadth	Least width of rostrum	Interorbital constriction	Postorbital constriction	Postpalatal constriction	Height of braincase at bullae
12653	♀ yg.	Price Creek, Humboldt County	97.4	106.4	70.9	64.7	25.5	22.9	20.3	14.7	41.8
19098	♂ ad.	Cuddeback, Humboldt County	97.9	106.3	73.4	66.5	26.1	22.7	19.5	14.2	41.7
19152	♂ ad.	Cuddeback, Humboldt County	100.1	109.5	75.3	67.1	27.0	24.9	20.0	14.0	41.1
19153	♂ yg.	Cuddeback, Humboldt County	101.0	110.4	71.7	65.1	26.7	24.3	19.7	13.5	40.1
19154	♂ ad.	Cuddeback, Humboldt County	97.4	106.7	72.1	66.7	26.4	26.2	19.0	13.8	41.2
20775*	♀ ad.	Grizzly Island, Solano County	98.5	106.8	70.0	64.9	24.3	23.5	21.0	13.7	41.6

* Type.

other skins from California are almost identical in these respects with the type of *brevipilosus*. All are full-pelaged winter skins.

As for name, the only synonym apparently requiring consideration is the "*Lutra californica* Gray," and this seems to have been disposed of with finality by Thomas (1889, p. 198), as applying to a South American form of remote relationship.

The type locality of *brevipilosus* is in the lowland area at the confluence of the Sacramento and San Joaquin rivers. In the included Suisun marshes are many sloughs in which the water varies, according to the tide and the stage of water in the rivers, from salt to nearly fresh, averaging brackish. From information obtained by Miss Alexander, as well as from other sources, river otters would appear to be even at the present time common along these channels. At least six are reported to have been killed in the vicinity the past winter. Good evidence is at hand that otters have occurred recently across the Suisun marshes as far west as Cordelia Slough.

Transmitted June 27, 1914.

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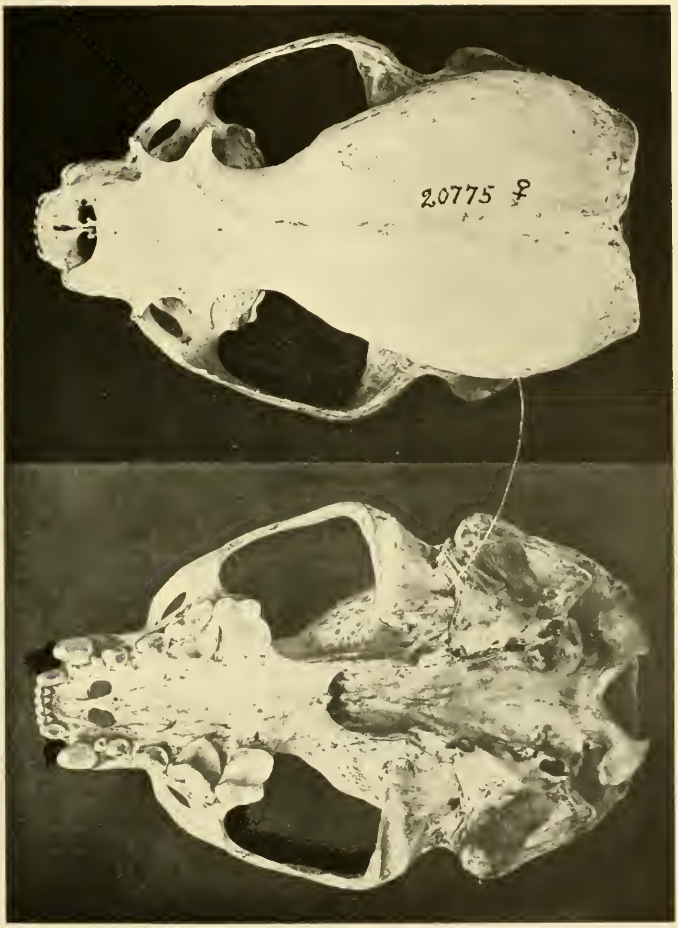
PLATE 14

Dorsal and ventral views of skull of *Lutra canadensis brevipilosus;* type, ♀ adult, no. 20775, Mus. Vert. Zool., Grizzly Island, Solano County, California. × 1.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FOUR NEW POCKET GOPHERS FROM CALIFORNIA

BY

JOSEPH GRINNELL

UNIVERSITY OF CALIFORNIA PRESS
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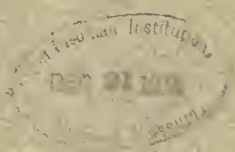

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FOUR NEW POCKET GOPHERS FROM CALIFORNIA

BY
JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The pocket gophers (genus *Thomomys*) offer an interesting problem in distribution and speciation. Reduced power of locomotion appears to have accentuated the action of barriers. Particularly in California, where topographical and climatic conditions are so varied, has differentiation of species proceeded to an extreme degree.

For the past seven years, particular attention has been paid by the staff of the California Museum of Vertebrate Zoology to obtaining material in this group, with the result that we now have 1749 specimens from localities within the state. But even this amount of material is far from sufficient for exhaustive and accurate treatment. There is, however, sufficient ground for placing on record at this time characterizations of certain new species and subspecies.

During a recent visit to this museum, Mr. Vernon Bailey, of the United States Department of Agriculture, went over our gophers for the purpose of gathering distributional data contributory to a revision of the North America gophers which he now has under way. The writer was privileged to work over part of the material with Mr. Bailey, and submit to him various questions. The validity of the supposed new forms was discussed, and during these discussions some of the writer's impressions were emended or corrected. The writer takes this opportunity to thank Mr. Bailey for his friendly and helpful suggestions in these regards.

Thomomys monticola premaxillaris, new subspecies

Yolla Bolly Gopher

Type.—♂ adult, no. 20242, Mus. Vert. Zool.; two miles south of South Yolla Bolly Mountain, altitude about 7500 feet, in Tehama County, California; August 6, 1913; collected by G. F. Ferris; original no. 166.

Diagnosis.—A member of the *monticola* series of gophers; palest of the forms known from California. Feet and ears small; premaxillary tongues extending far back of posterior ends of nasals; interparietal relatively broad antero-posteriorly.

Material.—Twenty-five specimens (nos. 20223–20247), from three localities in Tehama County, in the vicinity of South Yolla Bolly Mountain: two miles south of South Yolla Bolly, about 7500 feet altitude; four miles south of South Yolla Bolly, about 6000 feet altitude; Mount Linn (South Yolla Bolly of residents of the region), about 7600 feet altitude. All these localities are in Canadian or high Transition Zone; semi-arid in faunal condition; and on gravelly mountain slopes in coniferous forest association.

Measurements.—Of type (old adult male): Total length, 215 mm.; tail, 59; hind foot, 27; occipito-nasal length of cranium, 37.5; zygomatic width, 20.8; mastoid width, 18.6; height of braincase at bullae, 11.1. The hind foot averages, in thirteen adults of *premaxillaris*, 26.8 mm.

Comparison.—From near topotypes of *Thomomys monticola monticola* Allen, from the central Sierra Nevada, in Eldorado County, California, the new form differs in paler coloration (above close to ochraceous-tawny [of Ridgway, 1912], below light ochraceous-buff), in smaller ear, shorter hind foot, in slightly shorter and narrower rostrum of skull, in greater development of temporal ridges and in closer and more nearly parallel approximation of these, in extension of premaxillary tongues far back of posterior ends of nasals, and in shape of interparietal which is on an average relatively much broader antero-posteriorly. From topotypes of *T. monticola pinetorum* Merriam, *premaxillaris* differs in slightly paler coloration, in shape of interparietal, which averages very slightly broader antero-posteriorly, and in all other respects as from *T. m. monticola*. It may be remarked that the differences distinguishing *pinetorum* and *monticola* are at best extremely slight.

Thomomys diaboli, new species

Diablo Gopher

Type.—♀ adult (contained five embryos), no. 14165, Mus. Vert. Zool.; Sweeney's Ranch, in hills of Diablo Range twenty-two miles south of Los Baños, Merced County, California; April 2, 1911; collected by C. H. Richardson and H. A. Carr; original no. 108.

Diagnosis.—A member of the *bottae* series of gophers; smallest of all the forms so far known from west-central California; nearest in color to *Thomomys angularis angularis* Merriam, but slightly darker brown, especially beneath; other characters: small ears and feet, very weak and narrow rostrum, small teeth, moderately projecting incisors, and short nasals.

Material.—Seven specimens (nos. 14160–14165, 14696) from the type locality, as above; one (no. 16676) from top of divide on wagon road, 3000 feet altitude, in the Temblor Range, eleven miles west-northwest of McKittrick, Kern County, California. The latter specimen shows slight peculiarities of color and cranium, but is much nearer *diaboli* than any other form. In both places the zone is Upper Sonoran; rather arid; hillside juniper association.

Measurements.—Of type (adult female): total length, 180 mm.; tail, 60; hind foot, 25; occipito-nasal length of cranium, 32.9; zygomatic width, 22.0; mastoid width, 17.9; height of braincase at bullae, 11.6; length of nasals, 10.3. Total length of six adults: 180 to 193, average 189.

Comparisons.—From *Thomomys bottae bottae* (Eydoux and Gervais), of the San Francisco Bay region, the new form differs in very much smaller size, less blackish, more reddish, coloration, relatively smaller feet, smaller teeth, and weaker rostrum. From topotypes of *T. angularis angularis* Merriam, *diaboli* differs in much smaller size, relatively smaller feet and ears, slightly darker and browner coloration, much weaker rostrum, narrower incisors and less angular skull. From *T. leucodon navus* Merriam, of the Sacramento Valley, *diaboli* differs in slightly darker coloration, smaller size, much smaller molar teeth, smaller auditory bullae, much shorter nasals and narrower rostrum. From *T. nigricans nigricans* Rhoads, of the coast ranges of San Diego County, *diaboli* differs in slightly paler coloration, and notably in cranial characters: the nasals are much shorter, the incisors project far more, and the braincase is broader and more inflated

parietally. *Diaboli* is much like topotypes of *T. mewa* Merriam in size and coloration, though not quite so reddish in corresponding pelage, but differs in longer tail, and cranially in more bulging braincase, shorter nasals, and much more projecting incisors.

Thomomys infrapallidus, new species

Carrizo Plain Gopher

Type.—♂ old adult, no. 14181, Mus. Vert. Zool.; seven miles southeast of Simmler, Carrizo Plain, San Luis Obispo County, California; May 25, 1911; collected by H. S. Swarth; original no. 9138.

Diagnosis.—A member of the *bottae* series of gophers; palest of all the forms of this series so far as known from west-central California; nearest in color to *Thomomys angularis pascalis* Merriam, but decidedly paler beneath; other characters: relatively large feet, long fore claws, long tail, narrow and high braincase, moderately spreading zygomatic arches, moderately projecting incisors, small molar teeth, and very small auditory bullae.

Material.—Nine specimens (nos. 14179–14187, Mus. Vert. Zool.), all from Carrizo Plain, San Luis Obispo County, California: six from seven miles southeast of Simmler, and three from five miles north of Painted Rock; all collected in May, 1911, by H. S. Swarth. The altitude of the Carrizo Plain varies from 1900 to 2500 feet. Faunally and zonally it may be considered very arid, high Lower Sonoran. A sparse prairie vegetation grows on ground that is more or less strongly alkaline over most of the area.

Measurements.—Of type (old adult male): total length, 248 mm.; tail, 76; hind foot 34; occipito-nasal length of cranium, 43.0; zygomatic width, 29.0; mastoid width, 22.8; height of braincase at bullae, 14.0.

Comparisons.—From topotypes of *Thomomys bottae pallescens* Rhoads, the new form differs at a glance in much smaller auditory bullae, smaller and slenderer teeth, and more anteriorly projecting incisors. From *T. bottae bottae* (Eydoux and Gervais), *infrapallidus* differs in very much paler, more clayey, coloration, smaller general size, larger feet, longer tail, much smaller teeth, and smaller bullae. From topotypes of *T. angularis angularis* Merriam, *infrapallidus* differs in smaller size, paler coloration, especially below, narrower

braincase, and less squarely spreading zygomatic arches. From topotypes of *T. a. pascalis* Merriam, *infrapallidus* differs in paler coloration ventrally, larger feet, higher braincase, more projecting incisors and smaller auditory bullae.

Thomomys nigricans puertae, new subspecies

La Puerta Gopher

Type.—♂ young adult, no. 7511, Mus. Vert. Zool.; La Puerta (Mason's Ranch), eastern San Diego County, California; May 31, 1909; collected by F. Stephens; original no. 1974.

Diagnosis.—A pale desert-slope race of *Thomomys nigricans nigricans* Rhoads; apparently identical in size and cranial characters with that race; pelage mid-dorsally and around ears with far less admixture of black; general tone of coloration both above and below, ochraceous-tawny (of Ridgway, 1912), brightest on sides, and slightly subdued with dusky down middle of back; spot of sooty behind ear; face dusky.

Material.—The Museum contains forty-three specimens labelled La Puerta (nos. 7510–7519, 7582–7586, 16636–16654, 18822–18830). These are all of Mr. Stephens's collecting. According to his field notebook, the majority were caught in cultivated land on Mason's Ranch, which is located at the lower end of La Puerta Valley. Others, however, were taken on surrounding hillsides. Mason's Ranch is five miles west of Vallecito, on the old overland (Butterfield) stage-road. La Puerta Valley is evidently arid Lower Sonoran. Along the course of the stream arrowweed (*Pluchea*) is a common plant, while there is an occasional mesquite. The valley floor is mostly covered with large creosote bushes (*Larrea*).

Comparisons.—The series of La Puerta gophers is notably variable in color-tone. Picked specimens are fully as dark as the average of topotypes of *nigricans*, from Witch Creek, on the west side of the Cuyamaca Mountains. La Puerta is well down on the desert or east slope of the same general mountain mass, and less than ten miles away, so that it is quite possible that a continual invasion of true *nigricans* down on the east slope brings good examples of that form into the same valley with the more remotely derived and hence differentiated type here named *puertae*. Upon this theory the series at hand may be divided into bright-colored and dark-colored sections, the former meriting the name *puertae*, the latter *nigricans*.

It is obvious that *puertae* is a local, arid Lower Sonoran race of *nigricans*, the latter belonging to the closely-adjacent semi-humid Upper Sonoran of the various coast ranges of San Diego County, mostly on their western slopes. Typical *puertae*, as compared with typical *nigricans*, shows, in addition to the characters given above, a tail of uniform pale tawny color both above and below, instead of dusky above at base. From *T. cabezonae* Merriam, possibly also a subspecies of *nigricans*, *puertae* differs in more tawny coloration above (this obtaining in small young as well as in adults), invasion of tawny over under surface, more depressed rostral region of cranium, narrower interorbital constriction and braincase, and more widely spreading zygomata. From *T. bottae pallescens* Rhoads, *puertae* differs in smaller size, paler, more tawny coloration, lighter dentition, weaker and more depressed rostrum and smaller auditory bullae.

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THREE NEW RACES OF VESPERTILIONID BATS FROM CALIFORNIA

BY

HILDA WOOD GRINNELL

Smithsonian Institution
DEC 31 1914
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THREE NEW RACES OF VESPERTILIONID BATS FROM CALIFORNIA

BY

HILDA WOOD GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

During the past six years there has been accumulated in the Museum of Vertebrate Zoology a collection of eight hundred and thirteen specimens of bats from within the boundaries of California. Although material is still lacking from many important localities within the state, there is now at hand in several instances a sufficient number of specimens to show clearly the existence of certain hitherto unnamed races. Three of these new races are described below. In these descriptions all measurements are given in millimeters; total length, tail vertebrae and foot measured in the flesh by the collector. Color descriptions are based upon Ridgway's *Color Standards and Nomenclature* (1912).

The writer's thanks are due to Mr. Henry W. Henshaw, Chief of the Bureau of Biological Survey, United States Department of Agriculture, and to Mr. John Rowley, Curator of Mammals, California Academy of Sciences, for the loan of pertinent material used in comparisons.

Myotis californicus quercinus, new subspecies

Oak Foliage Bat

Type.—Female, adult; no. 6939, Mus. Vert. Zool.; Seven Oaks, 5000 feet altitude, San Bernardino Mountains, San Bernardino County, California; July 8, 1905; collected by J. Grinnell; original no. 1120.

Diagnosis.—Similar to *Myotis californicus californicus* (Audubon and Bachman) and *Myotis californicus pallidus* Stephens, but intermediate in color between these two forms. Prevailing tone of color on back, cinnamon.

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Description.—Ears, feet and fur as in *M. c. californicus*. Membranes and bases of hairs everywhere as in *californicus*. On the back the terminal portions of the fur are glossy cinnamon, and this color extends down onto the sides. The terminal portions of the hairs below are light buff in color, rather than buffy-brown as in *californicus*, or pale cartridge-buff as in *pallidus*.

Measurements.—A series of ten examples of *M. c. quercinus* from southern California averages in millimeters as follows: Total length, 81.6 (77.0–83.0); tail vertebrae, 36.8 (31.0–41.0); tibia, 14.1 (12.5–15.0); foot, 6.0 (4.0–8.0); forearm, 31.9 (31.0–33.2); greatest length of cranium, 13.1 (12.9–13.8); zygomatic breadth, 7.7 (7.4–8.0); breadth of braincase, 6.8 (6.6–7.0); interorbital constriction, 3.0 (2.9–3.3).

Specimens examined.—The writer has examined twenty-two specimens of *Myotis californicus quercinus* from the following localities in California: San Diego County—Cuyamaca, 2, Julian, 5; Santa Cruz Island—Friar's Harbor, 3; San Bernardino Mountains, San Bernardino County—Seven Oaks, 2, Bear Lake, 1, South Fork Santa Ana River, 2; San Jacinto Mountains, Riverside County—Kenworthy, 1, Schain's Ranch, 1; Tulare County—Trout Creek, 2; Ventura County—Matilija, 1, Mount Pinos, 2.

Remarks.—The three specimens listed from Santa Cruz Island, while slightly darker than typical *quercinus*, are still nearer to this form than to *M. c. californicus*.

Distribution.—The range of *M. c. quercinus*, as so far worked out, occupies portions of the San Diegan faunal division of southern California, and the Santa Barbara Islands. The life-zone is high Upper Sonoran and low Transition. The bats appear at late twilight and are usually observed flitting close about the foliage of scrub, golden, and black oaks.

Myotis yumanensis sociabilis, new subspecies

Tejon Bat

Type.—Female, adult; no. 5158, Mus. Vert. Zool.; Old Fort Tejon, 3200 feet altitude, Kern County, California; July 23, 1904; collected by J. Grinnell; original no. 715.

Diagnosis.—Similar in general characters to *Myotis yumanensis yumanensis* (H. Allen) and *Myotis yumanensis saturatus* Miller, but intermediate in color between these two forms.

Description.—The fur is distributed as in topotypes of *M. y. yumanensis.* On middle of back it averages about six millimeters in length. Hairs everywhere clove brown at base; distal half of fur on dorsal surface wood brown; fur below light buff, with darker bases of hairs showing through. On throat, sides and chin the color varies toward warm buff; ears olive brown; feet, wings and tail-membranes clove brown. The young are darker and grayer throughout, entirely lacking the buffy tint of the adults.

Measurements.—A series of five adult males of *M. y. sociabilis* averages in millimeters as follows: Total length, 81.4 (75.0–87.0); tail vertebrae, 33.3 (30.0–37.0); tibia, 15.2 (15.0–16.0); foot, 8.1 (7.0–10.0); forearm, 34.6 (32.9–35.3); greatest length of cranium, 13.7 (13.5–14.4); zygomatic breadth, 8.4 (8.0–8.6); breadth of braincase, 7.1 (6.7–7.6); interorbital constriction, 3.8 (3.5–3.9).

Ten adult females from Old Fort Tejon, Kern County, average in millimeters as follows: Total length, 81.9 (76.0–85.0); tail vertebrae, 36.6 (34.0–37.0); tibia, 14.7 (13.5–16.0); foot, 8.9 (8.0–10.0); forearm, 34.2 (33.7–35.0); greatest length of cranium, 13.8 (13.4–14.2); zygomatic breadth, 8.1 (7.8–8.3); breadth of braincase, 7.2 (6.7–7.3); interorbital constriction, 3.7 (3.6–4.0).

Specimens examined.—Total number sixty-nine, from the following localities in California: Butte County—Chambers Ravine, four miles north of Oroville, 1; Glenn County—Winslow, five miles west of Fruto, 1; Kern County—Old Fort Tejon, 61, Buttonwillow, 1 (Calif. Acad. Sci.); San Bernardino County—Bluff Lake, 7500 feet altitude, 3, Bear Lake, 6700 feet altitude, 1, South Fork Santa Ana River, 8500 feet altitude, 1.

Remarks.—Specimens of *M. y. sociabilis* from the San Bernardino Mountains show strong superficial resemblance to the smaller individuals among a series of *Myotis longicrus* (True) from the same locality. The longer tibia of the latter species, however, together with the slightly greater size of skull and the more elevated occipital region, serves to allocate individuals.

Distribution.—The distribution of this bat cannot be stated with confidence without much further field-work. It appears to occupy an intermediate geographic position between that of *M. y. yumanensis* and *M. y. saturatus,* namely the semi-arid Transition and Sonoran zones in California west and north of the southeastern deserts.

Corynorhinus macrotis intermedius, new subspecies

Intermediate Lump-nosed Bat

Type.—Female, adult; no. 7753, Mus. Vert. Zool.; Auburn, 1300 feet altitude, Placer County, California; July 31, 1909; collected by Dr. J. C. Hawver; original no. 2387, J. Grinnell.

Diagnosis.—Similar in general characters to *Corynorhinus macrotis pallescens* Miller and *Corynorhinus macrotis townsendi* (Cooper), but intermediate in color between these two forms.

Description.—As compared with *pallescens*, *intermedius* is somewhat larger in general size; ten examples of the latter form from Auburn, Placer County, average 102 millimeters in length, while ten specimens of *pallescens* from the San Jacinto region average but 97.2 in the same dimension. In color *intermedius* is natal brown above; below, wood brown; membranes bone brown.

Measurements.—A series of ten specimens from west central California averages in millimeters as follows: Total length, 102 (97.0–108.0); tail vertebrae, 48.6 (45.0–55.5); tibia, 19.7 (18.7–21.0); foot, 9.8 (9.0–12.5); forearm, 42.0 (40.2–43.6); greatest length of skull, 16.2 (15.4–17.1).

Specimens examined.—Total number, thirty-two, from the following localities in California: Placer County—Auburn, 23, Pioneer Cave, 3; Santa Catalina Island—Johnson Harbor, 1; Napa or Sonoma County—Mount Veeder, 1 (U. S. Biol. Surv.); Siskiyou County—Happy Camp, 1 (U. S. Biol. Surv.); San Benito County—Bear Valley, 2 (U. S. Biol. Surv.), Hernandez, 1 (Calif. Acad. Sci.).

Distribution.—The evidence at hand indicates that this bat occupies a geographic position intermediate between that of *pallescens* and that of *townsendi*, namely the semi-arid and semi-humid portions of the Upper Sonoran zone in California west of the desert divides.

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EUTAMIAS SONOMAE, A NEW CHIPMUNK FROM THE INNER NORTHERN COAST BELT OF CALIFORNIA

BY
JOSEPH GRINNELL

UNIVERSITY OF CALIFORNIA PRESS
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EUTAMIAS SONOMAE, A NEW CHIPMUNK FROM THE INNER NORTHERN COAST BELT OF CALIFORNIA

BY

JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The considerable series of chipmunks (genus *Eutamias*) in the California Museum of Vertebrate Zoology, accumulated from the coast district of California north of San Francisco Bay, consists of three distinct species. Two of these, *Eutamias hindsi* (Gray) and *Eutamias townsendi ochrogenys* Merriam, are already well known. The third is herewith described, and the opportunity is taken to give the distribution of all three species, as shown by the series of specimens at hand. In this connection, there have been available for comparison, through the courtesy of Mr. Henry W. Henshaw and Mr. Vernon Bailey, of the United States Biological Survey, forty-six additional specimens of *Eutamias hindsi*, from the national collection at Washington. Color names are taken from Ridgway's (1912) *Color Standards and Nomenclature*.

Eutamias sonomae, new species

Sonoma Chipmunk

Type.—♀ adult, in full summer pelage; no. 20825, Mus. Vert. Zool.; one mile west of Guerneville, Sonoma County, California; July 12, 1913; collected by J. and H. W. Grinnell; orig. no. 2250.

Diagnosis.—A member of the *townsendi* group of chipmunks (see Merriam, 1897, p. 194); nearest like *Eutamias hindsi*, from which it differs in greater size, relatively longer tail, longer ears, less deeply ferruginous tone of coloration dorsally, whiter lower surface, the three dorsal black stripes narrower, outermost light stripes whiter, post-

auricular spots larger and whiter, top of head and rump grayer in tone, and tail hairs distinctly tipped with gray.

Description.—Adult summer, or post-breeding, pelage (from type): Under parts from chin to base of tail, white, with creamy tinge mid-ventrally; insides of thighs and arms, light ochraceous-buff; upper surface of feet, dull ochraceous-tawny; sides and general suffusion over back, bright cinnamon-rufous, approaching apricot-orange in tone along the lower sides; narrow black median stripe from between ears to rump, fading out near base of tail; rest of dorsal stripes much shorter, not extending forward of shoulders; median dorsal stripe bordered on each side by a gray line, this much obscured with ferruginous; outwardly of gray stripe on each side is a black stripe dulled by intermixture of ferruginous hairs; succeeding this outwardly is a conspicuous clear ashy-white stripe on each side, and outwardly to this a much shorter stripe of dusky along the upper edge of the otherwise bright cinnamon-rufous side. There are thus three black stripes and four light stripes, the outermost pair of which is conspicuously whitish (much more clearly so than in *hindsi*). Rump and flanks, grizzled Brussels brown; tail beneath, bright Sanford's brown, outwardly margined with black and ashy white; tail dorsally black, with a little of the ochraceous-orange bases of the hairs showing through, and grizzled with the ashy-white hair tippings. Ears lightly lined inwardly with hazel hairs; front half of outer surface of ear, dull cinnamon-rufous, posterior half light mouse gray; triangular spot behind each ear, clear white, slightly tinged with ashy, but much more conspicuous than in *hindsi;* top of head grizzled grayish brown; head stripes more brightly contrasted with each other than in either *hindsi* or *ochrogenys;* stripes from nose to base of ear, above and below eye, white, slightly dulled with black and ferruginous hairs; a dusky stripe above each whitish supra-ocular stripe, becoming blacker anteriorly and meeting its fellow on tip of nose; a black stripe, dulled by ferruginous, from eye to base of ear; a similarly colored but narrower stripe beneath the whitish subocular stripe; a dull brownish suffusion between eye and snout; whiskers black. Measurements of type: total length, 260 mm.; tail vertebrae, 112; hind foot, 36; ear from crown, 17. Thirty adult specimens of *sonomae* average, as measured by field collectors: total length, 251 mm.; tail vertebrae, 113; ratio tail to body, 82 per cent. Eighteen adults of *hindsi* average: total length, 232 mm.; tail vertebrae, 102; ratio tail to body, 78 per cent. Cranial differences are not apparent. Breeding (worn winter) pelage: pattern

the same as above, but much duller in tones of color and hence with less of contrast; compared with corresponding stage in *hindsi*, grayer, less reddish; lower surface white instead of buffy; brown of tail much less reddish in tone, more ochraceous; dimensions diagnostic.

Distribution.—Of *Eutamias sonomae* there are 68 specimens in the Museum of Vertebrate Zoology, representing localities as follows: 5 miles south of Kunz, Trinity County, 1; Line Creek, 5500 ft. alt., 1 mile east of Castle Peak, near Trinity County line, Mendocino County, 1; 3 miles south of Covelo, Mendocino County, 9; 3 miles west of summit of Sanhedrin Mountain, 4500–6000 ft. alt., Mendocino County, 22; Lierly's Ranch, 2340 ft. alt., 4 miles south of Sanhedrin Mountain, Mendocino County, 2; 6 miles north of Willits, 1400 ft. alt., Mendocino County, 2; Rumsey, 500 ft. alt., Yolo County, 3; 8 miles west of Vacaville, Solano County, 5; 1 mile west of Guerneville, Sonoma County, 6; 7 miles west of Cazadero, Sonoma County, 15; Freestone, Sonoma County, 2.

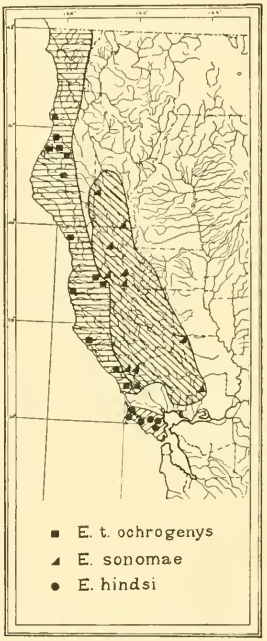

Fig. 1. Map of portion of northwestern California, north from San Francisco Bay, showing record stations and approximate ranges of *Eutamias townsendi ochrogenys*, *Eutamias sonomae*, and *Eutamias hindsi*.

Of *Eutamias townsendi ochrogenys* there are 129 specimens in this Museum, distributed as follows: Trinidad, Humboldt County, 4; Arcata, Humboldt County, 1; Freshwater, Humboldt County, 2; Eureka, Humboldt County, 7; Fair Oaks, Humboldt County, 17; Cuddeback, Humboldt County, 5; Rockport, Mendocino County, 1; Mendocino City, Mendocino County, 22; Sherwood, Mendocino County, 23; 5 miles north of Willits, Mendocino County, 1; Gualala, Mendocino County, 23; 7 miles west of Cazadero, 900 ft. alt., Sonoma County, 12; Freestone, Sonoma County, 11.

Of *Eutamias hindsi* there are available, from the collections of this

Museum and of the United States Biological Survey, 62 specimens, as follows, all from Marin County: Vicinity of Point Reyes, 3 to 5 miles west of Inverness, 12; Inverness, 5; Olema, 15; Lagunitas, 2; "Nicasio" (probably in near vicinity of San Geronimo), 26; Mailliard, 2.

Relationships and Ecology.—Eutamias sonomae shows itself to belong primarily to the Upper Sonoran and lower Transition zones, chiefly in the chaparral association, though locally invading the margins of the forest. The species further belongs to what has been called the Clear Lake subfauna, namely, the aggregation of animal species occupying the semi-humid inner coast ranges and intervening valleys, lying between the narrow coastal Redwood fauna on the west and the Sacramento fauna on the east, and extending from the vicinity of San Pablo and Suisun bays north into western Trinity County. *Eutamias hindsi* has similar zonal and associational restriction, but belongs to a more humid area, namely, that occupied by the Marin subfauna. This is a section of the coast belt proper, lying entirely within Marin County, and extending from Point Reyes eastwardly to include the slopes and foothills of Mount Tamalpais. *Eutamias townsendi ochrogenys* belongs to the Transition and Boreal zones in their narrow, humid-coast, faunal divisions. It is a dweller in chaparral and forest, and has not been found south of Freestone, Sonoma County. At the latter point *sonomae* and *ochrogenys* have been taken in the same lines of traps, as also at a point about seven miles west of Cazadero, Sonoma County. The ranges of these two chipmunks thus not only meet, but actually overlap to a slight extent. On the other hand, the range of *hindsi* is separated from the ranges of both *ochrogenys* and *sonomae* by a belt of country apparently unfit associationally for the existence of any one of this group of chipmunks. *Hindsi* is thus quite isolated from any of its relatives (see fig. 1).

It may be remarked that *hindsi* appears to be much nearer in aggregate of characters to *ochrogenys* than is *sonomae*. The latter is thus an extreme departure from the *townsendi* stock. *Sonomae* reminds one in several respects of *Eutamias quadrimaculatus* of the western flank of the central Sierra Nevada, and the species just named may well be a still further manifestation in the *townsendi* series.

Eutamias merriami pricei, of the Santa Cruz subfaunal area, belongs also to the *townsendi* group. It resembles *sonomae* in general aspect, but differs constantly and markedly in smaller ear, in dull gray instead of white postauricular spot, in light gray instead of

whitish outer side stripe, and in grayer, less brightly reddish, general tone of coloration dorsally. In the latter respect *pricei* differs still more strongly from *hindsi*. The ranges of the two chipmunks last mentioned are separated by San Francisco Bay and the Golden Gate, together of course with adjacent strips of territory associationally unfit for habitation by chipmunks.

Transmitted October 31, 1914.

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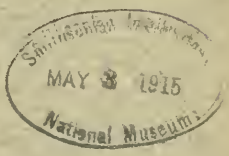
BATRACHOSEPS MAJOR AND *BUFO COGNATUS CALIFORNICUS*, NEW AMPHIBIA FROM SOUTHERN CALIFORNIA

BY

CHARLES LEWIS CAMP



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BATRACHOSEPS MAJOR AND *BUFO COGNATUS CALIFORNICUS*, NEW AMPHIBIA FROM SOUTHERN CALIFORNIA

Smithsonian Institution
MAY 8 1915
National Museum

BY

CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

During the author's examination of the amphibia from southern California contained in the collection of the Museum of Vertebrate Zoology, two forms have been distinguished which seem to deserve recognition under new names.

The occurrence of *Bufo cognatus* almost to the Pacific seaboard in California is of considerable interest, the previous westernmost published record being from the Colorado River. The detection of a new species of *Batrachoseps* in southern California is not to be wondered at, considering the obscurity of the descriptions in the literature relating to this genus. This new salamander is fairly common in the western part of the San Gabriel Valley, especially in the district immediately surrounding Pasadena.

Batrachoseps major, new species

Garden Salamander

Type.—Adult; no. 611, Mus. Vert. Zool.; Sierra Madre, 1000 feet altitude, Los Angeles County, California; March 14, 1909; collected by C. L. Camp; orig. no. 218.

Diagnosis.—A large, pale, long-limbed *Batrachoseps* with light yellow underparts. Costal folds 18, rarely 17 or 19.

Material.—Twenty-nine specimens from Pasadena and Sierra Madre, California; twelve from the latter and seventeen from the former locality; nos. 611, 954–956, 4566–4586, Mus. Vert. Zool.

Comparisons.—This species is intermediate in many of its characters between *Batrachoseps pacificus* from the northern Channel Islands and *Batrachoseps attenuatus* of the Pacific Coast district. Size larger than any of the other species of *Batrachoseps*, not quite so slender as *attenuatus;* head wider; tail shorter and limbs longer than in *attenuatus;* head narrower, tail longer and limbs shorter than in *pacificus.* Van Denburgh (1905, p. 8) states that the number of costal grooves in *B. pacificus* is 17, rarely 16 or 18; this would make the number of costal folds in that species 16, rarely 15 or 17.

To avoid confusion, the system of enumerating the costal folds as here employed should be set forth. For obvious reasons the costal grooves cannot be so accurately ascertained as the folds. The limbs may start in a groove or on a fold and so there may be in many cases fractional folds. These are never considered, only complete folds bounded on each side by grooves being taken into account. This makes the number of grooves always one more than the number of folds.

The costal folds in *B. major* number 18, rarely 17 or 19, the number of folds in *B. attenuatus* (from points in southern and middle California) is 18 or 19, rarely 17 or 20, the number in *B. caudatus* (Hassler Harbor, probably on Annette Island, southeastern Alaska) from the record of Cope (1889, p. 126) is 20 (21 grooves).

B. pacificus, with a wide head, short tail and body, longer limbs and few costal folds, stands nearest the *Plethodon* group of salamanders, while *B. caudatus,* the most specialized member of its genus, with a narrow head, shorter legs, slender body and long tail, lies, both structurally and geographically, at the opposite end of the scale. *B. attenuatus* is intermediate; and *B. major*, representing an apparently restricted local race, is between *pacificus* and *attenuatus* in its proportional measurements (see table, p. 330).

The coloration of the present species resembles that of *pacificus* more than that of *attenuatus.* It is distinct from *attenuatus* by reason of its pale color, especially of the ventral parts, which are yellow and never gray except in narrow transverse areas between the limbs. The dorsal surfaces are slightly paler than in *B. pacificus.* In Van Denburgh's redescription (1905, p. 8) of *pacificus* no mention is made of darker areas between the limbs on the ventral surface such as exist in *major.*

Description of type.—Body and tail elongate, cylindric, annulated; tail conical at tip, stout throughout its length, longer than body; head wider than neck, flat above, narrower than body in abdominal region;

fore and hind limbs do not meet when pressed to sides of body; digits rudimentary, four on both front and hind feet; nostrils separated by nearly twice their distance from the orbits, not terminal, connected with upper lip by thick-edged grooves; gular fold not plainly marked; body divided into eighteen folds, or segments, between the front and hind limbs; skin very smooth and shiny; openings of small pores barely visible on head region. Color in alcohol (from Ridgway's *Color Standards*, 1912) light neutral gray above; sides, lower parts, upper lip, palms and soles near cream buff; slightly darker on under surface of tail and on ventral surface of body transversely between limbs.

Variations.—In the series of twenty-five specimens at hand the costal folds number 17 in four, 18 in seventeen, and 19 in three. In one specimen there are 17 folds on one side and 18 on the other side of the body. In one specimen the outside (fourth) digit of the left front foot is lacking.

Distribution.—This large, light-colored *Batrachoseps* has been taken on south Euclid Avenue beneath boards in a yard, and also in a cellar, in Pasadena, California. The type was found in the neighboring town of Sierra Madre under a broken piece of cement sidewalk, and others taken in the same vicinity were captured in piles of damp lumber and in post-holes. Two were taken in August, 1905, several feet beneath the surface of the ground in loose gravel in a ravine bottom. The localities of capture lie in the upper edge of the Lower Sonoran life-zone (mesa oak association) and below the range of *Batrachoseps attenuatus*. The latter species appears to inhabit the Upper Sonoran zone (maple-sycamore association) in the mountain cañons, possibly getting out into the valleys occasionally along water courses. Both species are entirely terrestrial and both appear to estivate during the drier months, being then seldom found above ground.

COMPARATIVE MEASUREMENTS IN MILLIMETERS OF FOUR SPECIES OF *Batrachoseps*

Mus. no.	Locality[2]	Date	Measured by	Total length	Tail length	Head width	Fore limb	Hind limb	Between limbs	Costal folds	Costal grooves
			Batrachoseps pacificus								
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	45.	20.	3.5	5.	5.5	15.	16?	17?[6]
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	67.	31.	5.	7.	7.5	22.	16?	17?
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	113.	64.	7.	9.	9.5	31.	16?	17?
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	108.	56.	6.5	9.	9.5	36.	16?	17?
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	115.	63.	7.	8.5	9.5	33.	16?	17?
.....[3]	San Miguel Island	March, 1903	J. Van Denburgh	115.	59.	8.	9.	10.	38.	16?	17?
.....[4]	Santa Barbara(?)	Oct. 28, 1881?	E. D. Cope	71.	36.[5]	4.2	....	7.4	24.5	18?	....
			Batrachoseps major								
611[1]	Sierra Madre	Mar. 14, 1909	C. L. Camp	134.4	79.5[7]	6.4	7.4	8.2	34.1	18	19
954	Pasadena	Mar. 1, 1905	C. L. Camp	162.0	91.5	6.2	9.5	10.0	43.0	19	20
4568	Pasadena	Mar. 6, 1909	C. L. Camp	64.4	30.7	4.0	6.0	7.1	19.9	18	19
4367	Sierra Madre	May 2, 1908	C. L. Camp	115.5	66.0	5.9	7.1	8.3	30.0	18	19
4584	Pasadena	Dec. 21, 1910	C. L. Camp	108.4	58.5	5.4	7.9	8.3	32.4	19	20
4582	Pasadena	Dec. 21, 1910	C. L. Camp	99.5	57.7	4.6	6.3	7.4	25.5	17	18
4575	Sierra Madre	Dec. 3, 1910	C. L. Camp	74.9	39.6	4.7	5.6	6.8	21.5	18	19
4578	Pasadena	Dec. 21, 1910	C. L. Camp	82.7	37.7	5.1	6.4	7.4	26.5	17	18
			Batrachoseps attenuatus								
2385	Morago Valley, Contra Costa Co.	Feb. 22, 1910	C. L. Camp	111.0	66.3[7]	5.3	5.0	5.6	29.0	19	20
4700	Bailey Cañon, near Sierra Madre	Apr. 18, 1909	C. L. Camp	100.1	60.4	4.1	5.1	5.5	26.8	18	19
4629	2 miles southwest Napa	Dec. 16, 1912	C. L. Camp	74.9	38.6	4.2	5.2	5.7	24.1	18	19
4655	2 miles southwest Napa	Dec. 16, 1912	C. L. Camp	82.5	40.5	4.7	5.5	5.2	25.3	18	19
.....	2 miles southwest Napa	Jan. 24, 1915	C. L. Camp	124.2	73.9	4.2	5.5	5.9	35.0	19	20
			Batrachoseps caudatus								
.....[4]	Hassler Harbor, Alaska	.....	E. D. Cope	160.	103.[5]	6.	6.5	7.	29.5	20	21

[1] Type.
[2] In California unless otherwise stated.
[3] Collection of California Academy of Sciences.
[4] Collections of United States National Museum.
[5] Measured from "base of tail."
[6] "In fifty specimens the costal groves are: 17 in forty, 16 in six, and 18 in four."
[7] Measured from posterior end of anus in this series.

Bufo cognatus californicus, new subspecies

Arroyo Toad

Type.—Female, adult; no. 4364, Mus. Vert. Zool.; Santa Paula, 800 feet altitude, Ventura County, California; May 22, 1912; collected by C. L. Camp; orig. no. 551.

Diagnosis.—A toad with divergent head crests, a nasal boss, short, slightly divergent parotoids and with an internal, cutting tubercle on hind foot; femur short as in *Bufo cognatus cognatus*, the Great Plains toad. Size medium; parotoids wide; coloration nearly uniform, without large spots; no vertebral streak; external tubercle on hind foot small and rounded, not provided with a cutting edge.

Material.—Two alcoholic specimens: the type; and adult female, no. 767, Mus. Vert. Zool.; Tujunga Wash, near Sunland, Los Angeles County, California; April 1, 1904; collected by J. Grinnell.

Comparisons.—This *Bufo* is distinct from the common toad (*Bufo halophilus*) of the Los Angeles region, differing from it: in the possession of both transverse and longitudinal cranial crests, in the smaller size, in the absence of a vertebral stripe, in the thick head, and in the more even character of the tuberculation of the back. It is clearly most closely related to *Bufo cognatus cognatus* Say (1823, **2**, p. 190) of Arizona and the Great Plains, east of the Rockies.

The type locality of the latter is the Arkansas River in Colorado, probably between the present site of La Junta, Colorado, and the Colorado-Kansas boundary. *Bufo cognatus* ranges over a large part of the Great Plains district east of the Rocky Mountains, in Colorado, Kansas, Arkansas, New Mexico, Texas, Nebraska, Montana, and South Dakota. West of the Rockies it occurs in northern Mexico, Arizona, and, in southeastern California, along the Colorado River and in the Salton Basin.

The two specimens here included in the subspecies *californicus* are the first representatives of this species known from the Pacific coast of California. They differ from a series at hand of *Bufo cognatus* taken on the Colorado River, in California and Arizona, in the slightly longer hind foot, in the lack of an external cutting tubercle, in the width of the parotoids, which are 10 to 20 per cent broader in *californicus*, and in the type of coloration, which is uniform and without a trace of the large green spots, so pronounced a feature of the coloration of most of the Colorado River examples.

From *Bufo lentiginosus woodhousii*, of the Lower Colorado River district and farther east, the new toad differs decidedly in its smaller size, short hind legs, divergent cranial crests, and in the presence of a bony nasal elevation.

Description of type.—Size medium; hind legs very short, femur almost entirely enclosed in skin of abdomen; head short and thick; nasal region elevated into a bony protuberance; longitudinal cranial crests more or less united across median region, and slightly divergent; transverse crests divided by width of median groove; parotoids oval, slightly divergent and very broad; inner tubercle of hind foot with a sharp edge; outer tubercle very small, rounded and without cutting edge; eyelids and back evenly tuberculated; tympanum oval, shorter than diameter of eye; a dozen or more large whitish tubereles below and just posterior to the tympanum. The color when taken was light olive-green above, with two light patches about six millimeters in diameter immediately behind the parotoids. Upper lip below the eye barred vertically with paler tone; light areas present on eyelids and anterior ends of parotoids. No vertebral stripe present; underparts creamy white, unspotted. Bases of several of the tubercules on the back encircled by small black rings, and no large greenish spots in the dorsal coloration.

Distribution.—The type was found on a lawn in the middle of town, about eight o'clock in the evening. The Santa Paula district is about sixty miles east of the San Fernando Valley (where the other specimen of this subspecies was found), and a mountain spur about one thousand feet in elevation separates the two localities of capture. Both localities lie within the San Diegan faunal area in the Lower Sonoran life-zone, as the latter has been delimited in California. Both localities are of semi-arid character, and the streams are intermittent in the arroyos near which each of these toads was captured.

MEASUREMENTS IN MILLIMETERS OF THE TWO SUBSPECIES OF *Bufo cognatus*

Mus. no.	Sex	Locality[2]	Date	Total length[3]	Head length	Head width	Hind leg[4]	Tibia	Hind foot[5]	Length of parotoid	Width of parotoid
			Bufo cognatus californicus								
4364	♀	Santa Paula, Ventura Co.	May 22, 1912	64.5	19.2	23.5	84.4	26.3	41.5	10.5	7.8
767	♀	Tujunga Valley, Los Angeles Co.	Apr. 1, 1904	58.5	18.0	22.6	83.8	25.9	41.3	11.9	7.4
			Bufo cognatus cognatus								
1139	♂	Needles, San Bernardino Co.	July 16, 1909	60.2	18.0	22.7	80.4	25.0	38.7	8.8	5.5
4361	♂	Needles, San Bernardino Co.	July 16, 1909	59.1	17.9	21.8	75.5	23.6	36.3	8.9	4.9
4358	♀	Needles, San Bernardino Co.	July 16, 1909	60.3	19.0	23.8	81.8	24.7	40.1	9.6	5.2
4360	♀	Needles, San Bernardino Co.	July 16, 1909	62.5	19.4	22.6	78.0	25.1	38.9	9.0	5.5
4363	♂	Needles, San Bernardino Co.	July 16, 1909	62.5	19.1	23.0	81.6	25.9	38.5	9.2	4.6
1137	♂	Needles, San Bernardino Co.	July 15, 1909	58.5	17.7	21.3	76.8	23.1	36.6	8.5	5.2
1134	♂	Needles, San Bernardino Co.	July 16, 1909	63.7	20.0	22.9	78.8?	25.5	38.0?	9.8	5.6
457	♀	Mecca, Riverside Co.	Apr. 21, 1908	64.9	19.4	24.0	79.4	26.0	37.8	9.5	6.1
21070[1]	♂	Ft. Huachuca, Arizona	July, 1893	60.0	17.7	21.6	.....	21.1	34.6	11.3	6.3
21065[1]	♀	Animas Valley (Colorado?)	Sept. 9, 1895?	89.8	22.3	28.8	96.6	31.8	49.5	12.1	7.2
2562[1]	♂	Red River, Arkansas	.....	88.5	25.0	31.5	113.1	33.6	54.4	14.5	8.1

[1] From collections of United States National Museum.
[2] In California unless otherwise stated.
[3] Tip of snout to posterior border of pubic symphysis.
[4] From pubic symphysis.
[5] Including tarsus.

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BY
LOUISE KELLOGG

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BY
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BY

LOUISE KELLOGG

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Smithsonian Institution
FEB 25 1916
National Museum

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INTRODUCTION

The Trinity, Salmon and Scott mountains form a chain lying in an intermediate position between the Sierra Nevada and the Coast Ranges, on the east and west, respectively, and merging through the Siskiyou Mountains at the north into the Cascade Range. The river systems which drain this chain of mountains occupy valleys somewhat similar to those which furrow the western flank of the Sierra Nevada. The streams all flow ultimately in a westerly direction and finally meet the Klamath River, which forms their common outlet to the seacoast. There is thus offered an interesting problem in animal distribution; for the faunas of the Sierra Nevada to the east, the Coast belt to the west, and the Cascades

to the north, are decidedly different from one another. The fauna of the Trinity region could reasonably be expected to have resulted from an intermingling of forms from all three directions.

With a view to obtaining exact information pertaining to the fauna and flora of this region, embracing a part of northeastern Trinity County, southwestern Siskiyou County and a corner of northwestern Shasta County, Miss Annie M. Alexander organized and financed two trips, one in February and March, 1911, to Helena, Trinity County, and another during the summer months of the same year, over the wider territory indicated in detail in the following itinerary and on the map (fig. A, page 337). The specimens obtained, numbering 449 birds, and 976 mammals, have been presented by Miss Alexander to the California Museum of Vertebrate Zoology. The present report is based upon these specimens and is supplemented from the field notes of the collectors.

ITINERARY

SCHEDULE

Helena, Trinity County, February 11 to February 26, 1911.

Tower House, Shasta County, February 28 to March 8.

Mayten, Siskiyou County, June 3 to June 6.

Scott River, 6 miles northwest of Callahan, Siskiyou County, June 7 to June 14.

Jackson Lake, Siskiyou County, June 15 to June 27.

Wildcat Peak, Siskiyou County, June 27 to June 30.

North Fork of Coffee Creek, Trinity County, July 1 to July 9.

Saloon Creek Divide, Siskiyou County, July 9 to July 10.

South Fork of Salmon River, Siskiyou County, July 12 to July 17.

Summerville, Siskiyou County, July 17 to July 19.

Hunters' Camp, Trinity County, July 19 to July 20.

Head of Grizzly Creek, Trinity County, July 20 to July 25.

Head of Rush Creek, Siskiyou County, July 26 to August 2.

Kangaroo Creek, Siskiyou County, August 3 to August 5.

Head of Bear Creek, Trinity County, August 5 to August 17.

Castle Lake, Siskiyou County, August 18 to August 23.

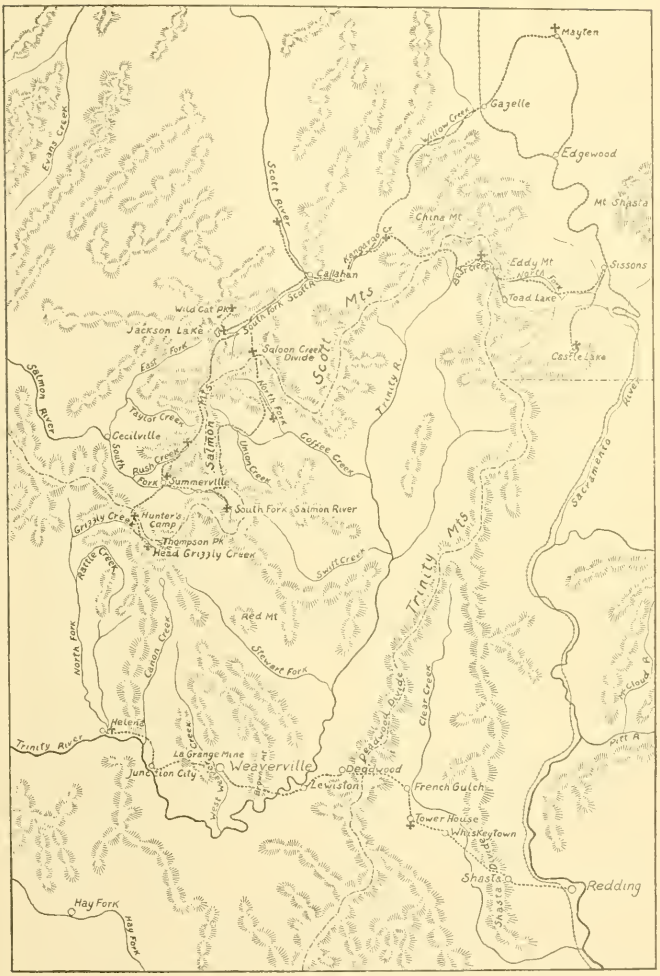

Fig. A. Map of portions of Siskiyou, Trinity and Shasta counties, showing routes (broken lines) traversed by Miss Annie M. Alexander and Miss Louise Kellogg in their zoological explorations of the region.

DESCRIPTION OF ROUTE

As a preliminary to the work of the summer, Miss Alexander and the writer spent a month, from February 10 to March 8, 1911, at Helena, on the North Fork of the Trinity River, in Trinity County, and at Tower House, in Shasta County.

We went by stage from Redding, Shasta County, following the Sacramento River for about three miles, then up Shasta Creek and over the Shasta divide, elevated 1800 feet above sea level, down into the valley of Clear Creek to Tower House and French Gulch, and from there over the Deadwood divide, 4550 feet by aneroid, to Lewiston, on the Trinity River.

The east slope of the Shasta divide presents a scene of desolation as a result of the killing of the trees by fumes from the smelters. On the west side the vegetation is more flourishing, but miles of timber and chaparral have been demolished by forest fires. When we crossed the Deadwood divide, February 9, there was much snow near the summit. We saw very few birds, only a flock of chickadees and kinglets, and a few quail. Mammals were even less in evidence, although in places we saw a few tracks in the snow near the road. Only one chipmunk and one gray squirrel were actually seen on the entire stage trip through to Weaverville.

We spent the night at Lewiston and went on the next day to Weaverville, following the Trinity River for about three miles, crossing it and climbing over the shoulder of Brown Mountain, and down into Weaverville, arriving there February 10. Consultation with some of the people of the town seemed to point to Helena, on the North Fork of the Trinity, as being a good place for trapping, and further desirable because George Knowles, considered to be one of the best trappers in the county, was staying there. It is an eighteen mile drive up West Weaver Creek, then over the Oregon Gulch Mountain, 1050 feet, and down the gulch to Junction City on the Trinity River. This Oregon Gulch is being filled up at the rapid rate of twelve feet a month by debris from the La Grange hydraulic mine. The water of the Trinity River itself is turbid from the many mines scattered along its course. From Junction City we turned up Cañon Creek for a short distance, then doubled back to the Trinity and followed it down to where the North Fork empties into the main stream. The water of North Fork was beautifully clear in contrast to that of the muddy main river, and its

narrow cañon leading up to a mass of snow-covered peaks gave one the impression of having entered a really wild and rugged country. Below North Fork, or Helena, as the small settlement is called, the Trinity River enters a deep rocky cañon.

Helena is a postoffice town consisting of a hotel, store and couple of houses, situated at the junction of the Trinity River and its North Fork. The narrow cañon of the North Fork opens out enough to make a little farming possible; but the wooded hills rise close on every side, with higher mountains in sight just beyond. The principal trees and shrubs noted in the vicinity were: digger pine, Douglas fir, oaks, ceanothus and poison oak. This is considered a good trapping country for such fur-bearing mammals as fox, coon, skunk, civet cat, and, to a less extent, fisher. Larger mammals such as black-tailed deer, wild-cat and mountain lion were reported common. The life-zone at Helena is Upper Sonoran, with many Transition elements intruding from the closely surrounding area of pure Transition.

We spent two weeks collecting at Helena, and then returned by way of Weaverville back along the stage line as far as Tower House, where we stayed for ten days, returning then to Oakland March 9.

Tower House is a hotel resort at the lower end of Clear Creek Valley, eighteen miles from Redding. A violent storm which raged during most of our stay kept us from seeing much of the surrounding country, but it appeared to be a place typical of the worked-out mining region so prevalent in Shasta County. The interests of the people center in the cultivation of small farms and in the cutting of wood. The tree stand is of digger pine and oak, and the chaparral consists of deer brush and manzanita. The zone may be considered Upper Sonoran.

We made our second start from Oakland on the evening of June 3, with John Howard as assistant. We left the train at Edgewood, Siskiyou County, and went by team to Mayten, twelve miles to the northward in Shasta Valley.

Mayten is perhaps better known by the name of Big Spring, which is more specifically applied to a wet meadow several acres in extent in the center of Shasta Valley. The spring itself forms one of the sources of the Shasta River. A dam at the head of the spring backs the water up, forming a small lake, along the edge

of which tules grow abundantly. The people told us that ducks occur here plentifully during the winter and that a few stragglers remain and nest. The water is used for irrigation, but the rocky nature of the soil in this part of the valley makes agriculture difficult. Bird and mammal life centers close around the spring and where the land is cultivated. We had hoped to obtain here, at the type locality, specimens of *Reithrodontomys megalotis klamathensis* and might have had better success if we had trapped in a hayfield. As it was, near the spring, we did not get any. One farmer reported kangaroo rats as being abundant in the upper part of the valley where the soil is better and farming is carried on to a greater extent, but we saw no sign of them ourselves. Sage-brush grows on the rocky, uncultivated ground, and the scattering trees are juniper and small yellow pine. The region is distinctly Upper Sonoran in zone. We stayed here only two days, and then went to Gazelle, a small town on the line of the railroad and the first station north from Edgewood. While staying there over the night of June 6 so as to get the stage to Callahan, we set a few gopher traps in an alfalfa field close to the town, securing specimens of *Thomomys leucodon navus*. Our observations were naturally limited, but indications pointed to the same zonal position as Mayten, namely Upper Sonoran.

We left Gazelle the morning of June 7 by stage for Callahan, twenty-five miles to the west and at the south end of Scott River Valley. We passed over a divide of about five thousand feet altitude and reached Callahan a little after noon. As the immediate vicinity of the town did not look favorable for collecting we drove about six miles down the valley and made camp on a small slough tributary to the Scott River. According to report there was still too much snow in the mountains for us to attempt to go up to a high altitude, so we put in the time from June 8 to 14 collecting at this camp.

Scott River Valley is a fertile stretch some twenty-four miles long and varying in width from one to six miles. It is hemmed in on the east by low rocky hills covered with sage-brush and ceanothus, with a scattering growth of yellow pine and oak (see pl. 15, fig. 1). On the western side the hills are somewhat more rugged and heavily timbered, and numerous small streams make their way down narrow eañons into the main river. The town of Callahan

lies at the extreme southern point of the valley, where the river makes its entrance from a cañon about a mile wide and six miles long. Beyond this lies the main valley, but we did not go farther north than our camp, which was situated just where the valley begins to widen. The altitude is 3000 feet.

The water from the river is used extensively for irrigation. We were told that about fifty years ago the whole stream was diverted to the eastern side of the valley where it now runs, perhaps to facilitate in some way the use of the water. Our camp was situated in the old river-bed; the sandy bottom-land, undisturbed, has gradually become covered with a dense growth of cottonwoods and willows. Zonally the valley is mainly Upper Sonoran, but there are a number of Transition elements mixed in. Of particular interest was the discovery of *Dipodomys*, which finds here an ideal home in the sand of the river-bed. Birds, of the streamside category, were numerous.

As the weather had become very warm we decided to go up to Jackson Lake on the eastern slope of the Salmon Mountains. The move was made on June 15, and this may be considered our first base camp on the main line of the proposed fieldwork. We secured the services of Mr. John Baker as guide and hunter, with five pack animals to be used in transporting our outfit from camp to camp.

Jackson Lake is a nearly circular bit of water, at an altitude of 6000 feet, lying in an amphitheater of rocky peaks. The highest of these, situated on the north side of the lake, is called Wildcat Peak. The only break in the rocky wall is where Jackson Creek flows out from the lake to the east down a narrow valley, green with meadows and alder thickets. A thick stand of yellow pine, fir, spruce, hemlock, tamrac pine, and some sugar pine, fills in this open side of the lake and extends back up along the side of Wildcat Peak almost to its barren summit. On our arrival, June 15, there was still much snow around the lake, especially on the rugged south side, with a few patches in the woods. There is a small pebbly beach on the north side of the lake, but for the most part the rocks descend sheer into the water. Several small streams enter the lake on the south, east, and north. We had fortunately arrived early enough to avoid any running of cattle or sheep into the meadows, and as the timber around the lake has not been cut, it was

as natural and unsullied a collecting ground as one would wish to find. The variety of mammal life confirmed this idea thoroughly, for the locality yielded the greatest number of species of any of our camping places, with the exception of Helena. Birds were not numerous as to individuals except for chickadees and juncos.

Judging from the mammalian fauna and the trees the region is in the Canadian division of the Boreal zone. Among the mammals taken were: golden-mantled ground squirrel, flying squirrel, mountain beaver, bushy-tailed wood rat, red-backed mouse, mink and marten.

Wildcat Peak was visited as a side trip of three days, June 27 to 30. This is considered the highest point near the Lake, having an elevation of 7200 feet. We accomplished almost nothing in the collecting line while there, both because of the apparent scarcity of small mammals and birds and on account of a severe storm of rain and sleet. Our camp was about 300 feet below the summit, at the upper limit of the red fir growth. There were a few scattering firs above, and some white-barked pines; but the top of the ridge is very narrow and rocky, falling off abruptly to the north. From the summit one obtains a comprehensive view of the Scott and Salmon mountains to the south and west, and of Mount Shasta to the east. There was almost no life at this altitude; but the fact was due probably not so much to the height as to the barren, rocky nature of the ground. But five species of small mammals were taken, one an *Aplodontia* secured in a meadow below the peak on the north side. Birds were as scarce as mammals. The trees indicate that the peak rises barely into the Hudsonian zone.

Our next move, July 1, was to the North Fork of Coffee Creek, almost due south across Saloon Creek divide, 6850 feet, in Trinity County.

North Fork of Coffee Creek is a good-sized stream making its way precipitately down a narrow, well-wooded cañon. There are numerous small meadows where creeks make into the main stream, the banks of which are densely clothed with alders. The timber is mainly white fir, Douglas fir, yellow, sugar, and silver pine, cedar, and a few cottonwoods. This growth does not extend far above the creek bed on the north side, but gives way to a dense growth of deer oak and white-flowered ceanothus which was in full bloom. Our camp was at the junction of the North Fork of Coffee Creek with Granite Creek, at an elevation of 4500 feet, with only

1500 feet difference between it and Jackson Lake, but the difference in temperature and the character of the surroundings was very marked. Here we were in full summer, while there it was spring. Just above our camp was a deer lick well known to our guide, and he told great tales of the deer he had seen in that lick. The zone may be considered Transition, but this diagnosis was based more upon the vegetation than upon the animal life, for we found here several Boreal mammals which thus ranged well down into the Transition, *Zapus* for example.

Saloon Creek Divide.—On July 9, Miss Alexander and I made a trip back to Saloon Creek Divide, staying one night and putting in the afternoon and morning in collecting. This divide, of 6850 feet altitude, forms part of the line between Trinity and Siskiyou counties. On the northern, Siskiyou, side, which is almost devoid of trees, a descent of about 500 feet brings one to a small stream fed from the snow banks of the divide (see pl. 15, fig. 2). Here we had seen numerous holes of the golden-mantled ground squirrel, and it was to collect some of these that we made the trip up from the North Fork. The southern side is equally steep, but covered thickly with ceanothus brush. We camped on the north side in a grove of red fir and devoted our collecting to ground squirrels and chipmunks. This was the first time we had ever found such a colony of the former *(Callospermophilus)*. Their burrows were under every rock, as well as out in the open, and we could see many of the animals running about or sunning themselves on the rocks. We expected to find *Microtus* and *Zapus* in the alders along the stream, but the ground had been so beaten down by cattle that the smaller mammals had evidently not thriven.

After twelve days on the North Fork, we started out again, following up the creek and then striking across a 6100-foot divide and down gradually to the main Coffee Creek. We camped the night of July 11 about a mile above its junction with Union Creek. The next day we proceeded up the creek to the Salmon Flats, large mountain meadows which form a low divide between Trinity and Siskiyou counties. The ascent was a gradual one and the vegetation abundant at the divide itself. Cottonwoods attain an immense size in the moist creek bottomland, and willows form dense thickets on either side of the stream. From the divide we went up the South Fork of the Salmon River about two miles and camped in

a small grove of pines by the river, where we stayed from July 12 to 17. Here we found ourselves again in Siskiyou County.

South Fork of the Salmon River heads in a semicircle of high peaks of about 7500 feet altitude. Our camp was at an altitude of 5000 feet, on the edge of a fine meadow of white clover interspersed here and there with large patches of false hellebore. Southwest of us, looming up across the river, was a high rocky peak with a good bit of snow on it, and beyond that was a sharp-pointed peak of solid rock with precipitous sides, probably about 8000 feet in height. There is no heavy timber on either side of the valley, but more on the east side than the west, where the mountains are rocky and covered mostly with chaparral. The trees around us were yellow, sugar, and tamrac pine, white fir, and Douglas fir. The banks of the river were brushy with alders and willows. We had evidently again reached the Canadian zone, and a few new birds were added to the inevitable juncos and chickadees in the way of kinglets, both ruby-crowned and golden-crowned, Lincoln sparrows, and creepers.

Summerville, eleven miles down the river, was our next objective point. This is the name given to a series of mines and farms along the main Salmon River, 2000 feet below our last camp. The change from firs and tamrac pines to oak, manzanita and scattered madrone was very marked. The country looked dry and unattractive after the higher mountain region; but the land can be made to produce well under irrigation, as we saw on the farm of Mr. Jack Hinz at whose place we stopped. His land lies on a bench some distance above the river, back of which rise the hills, while between them and the stream stretches a strip of glaring rock and sand, the remains of former hydraulic mining. Across the river the mountains rise steeply to a height of 5600 feet, covered below with black oak, madrone, Douglas fir and sugar pine, and higher up with a chaparral of chinquapin, white ceanothus and manzanita, which runs to the top of the ridge. The zone at Summerville may be considered high Upper Sonoran, with close investment on all sides by Transition.

At Summerville we added to our party Mr. Jack Hinz, at whose ranch we camped for a night, and who proved familiar enough with the country to be able to follow up an old government trail leading to the head of Grizzly Creek. Here we would be within reach of the highest peak in the Salmon Mountains. It took us two

days from Summerville to reach the head of Grizzly Creek, the night of July 19 being spent at Hunters' Camp.

Hunters' Camp, used by hunters and cattle men, is situated about a hundred feet down on the southern slope of the divide between Salmon River and Grizzly Creek, in a grove of white fir. The slope down to Grizzly Creek is very steep and the underbrush of chinquapin and ceanothus dense. There is a good spring coming out just below the camp, and its downward course is marked by dense alder clumps. Mr. Hinz says he often comes up on this ridge during the winter to trap, and has caught several fisher here.

The trail up Grizzly Creek from Hunter's Camp had been blazed years ago by a government surveying party which had made the ascent of a peak next to that known as Thompson Peak, and considered the highest point of the Salmon Range. We were unable to ascertain the name of this peak from any of the people in the region, and it is not given on the maps, but is so close to Thompson Peak and so nearly of the same height that for the sake of convenience it also may be called Thompson Peak.

Grizzly Creek has as its source a fair-sized lake lying in a rocky bowl between the mountains, and fed by great snow banks. The outlet of the lake is a waterfall which makes a sheer leap of about fifty feet over a rocky wall, and then by a succession of smaller drops descends into Grizzly Cañon. Our camp was just at the base of this precipice in a clump of red fir, white pine, and hemlock, flanked by large open meadows and willow thickets.

In scenic beauty this spot surpassed any of our other camping places (see pl. 17, fig. 5), but collecting was rather arduous on account of the ruggedness of the ground and the steep slopes, either up or down; for the cañon is hemmed in on all sides, except in the direction of its outlet, by rocky walls. Small mammals were not particularly abundant, and Mr. Hinz attributed the lack of marten and fisher sign to the absence this year of suitable food, especially chipmunks. *Aplodontia* sign was abundant in a small cañon where a stream and alders provided their favorite habitat (see pl. 16, fig. 3), and *Zapus* and flying squirrels were secured. One deer was shot high up on the crest of the mountain a thousand feet above camp. Save for elusive thrushes which sang in the underbrush, birds were rather scarce right around our camp. The density of the tree growth probably accounted for this. In the

more open places and meadows the birds were about as plentiful as at other camps. This locality is in the Canadian zone.

Our aneroid registered 7900 feet at the top of Thompson Peak, which is a pointed mass of rock dropping off steeply on all sides and surmounted by a government monument. Except for the last hundred feet or so up this point, the ascent of the mountain was not difficult, mainly over great stretches of granite rock and snow slides until we reached a granite ridge which forms the main approach to the peak. About half way up we obtained a good view of the lake which is the source of Grizzly Creek. There was ice still in it and we were told that the snow bank between the two peaks, from which it is fed, never entirely melts. On the eastern slope of the ridge were wind-blown specimens of white-bark and foxtail pines forming a heavy growth, while on the western slope tongues of hemlock ran up the mountain sides.

The view from the summit well repaid us for the climb. On the east was Mount Shasta; directly below us to the south, two small lakes which constitute the source of the Stewart Fork of the Trinity River. Rattlesnake Creek also heads off to the south, separated from Stewart Fork by a jagged crest of rocks. The watershed of the Rattlesnake is fan-shaped, the granite smooth as if planed by glaciers, but covered with a scattering growth of pines and hemlocks. To the south and west we saw the Trinity Mountains and the Coast range; in fact, as far as the eye could reach, there were mountains. We were told that Mount Hood can be seen from here on a clear day, but this sounds like an exaggeration. We collected specimens of red and white heather and other plants of the Hudsonian zone.

We put in four days collecting on Grizzly Creek and then returned to Summerville. Another night, that of July 25, at Hinz's ranch and we were off up Rush Creek to its head, where we camped in a large meadow.

Rush Creek heads in broad, open meadows with occasional strips of alders (see pl. 17, fig. 6). Patches of red fir skirt the outer edges of the meadows and extend up to the divide, which rises on either side of the lowest point of the saddle. Our camp was at an altitude of 6400 feet, with the divide some thousand feet higher. The outlook to the south and west was quite comprehensive and we could see directly across to the two Thompson Peaks with the snow bank between. A side cañon to the south of our camp con-

tained a small lake surrounded by trees and proved a favorite haunt of birds. The meadow was variegated with flowers, hellebore, painted cup, and larkspur. The cattlemen say that larkspur and wild parsley are fatal to cattle and they never keep their stock more than one night in this region. They claim horses are not affected. Flying squirrels were abundant and easily trapped in the higher groves of red fir, and we also secured several marten here. Mr. Baker shot a magnificent buck on a high ridge to the south. *Zapus* lived among the alders along the stream. The Lincoln sparrow was nesting here in a clump of hellebore. The zone may be therefore considered Canadian.

On August 2 we made a forced march back to Callahan, over the Rush Creek Divide, around the heads of Taylor Creek and one of the branches of Coffee Creek, down into the East Fork of the Salmon River, up again until we struck the Scott River watershed, and thence down into Callahan.

Kangaroo Creek, a tributary of Scott River, then became our base of operations. Our camp here was situated at some deserted mining cabins about eight miles northeast from Callahan and several hundred feet higher, at an altitude of 3300 feet. We were disappointed to find that hydraulic mining had been carried on in the creek, thus spoiling all the natural aspect of the place. Also there was almost no water except from a small spring near the buildings, so that any hope of finding many small mammals was vain. The side-hills were dry and unattractive, and birds consequently scarce.

The thing of chief interest about the place was the mixture of zones, for we here found round-tailed wood rats and bushy-tailed ones inhabiting the same cabins. Also there were golden-mantled ground squirrels, which, with the bushy-tailed wood rats, must have been at the lowest line of their distribution. The place being shut in, as it is, in the cañon, is probably somewhat colder in winter than at Callahan, although there is so little difference in altitude and general conditions; this, combined with heavier timber, may account for the presence of the two high-zone mammals named. The tree stand is chiefly yellow pine. The locality may be considered prevailingly Transition.

The collecting at Kangaroo Creek was so disappointing that after two days' work we were glad to start for Bear Creek, one of the northern tributaries of the Trinity River, and at the base of

Mount Eddy. Here we remained from August 5 to 17, and, besides making the ascent of Mount Eddy, we spent a day at Toad Lake, one of the sources of the Sacramento River.

Bear Creek is the second tributary from the head of Trinity River. We camped almost at its head, altitude about 6000 feet, in an attractive meadow, dotted with clumps of tamrac pine, alder, and willow, and supporting a heavy growth of grass and rank hellebore. Several acres had been fenced in by the forest rangers so that they could have a place in which to pasture their horses, that had not been trampled by the hordes of cattle. The trail from Kangaroo Creek, for the most part through sparsely wooded hills and open rocky stretches, had not prepared our minds for anything so green and inviting as this stopping-place proved to be, so we were very agreeably disappointed in it, and found the collecting excellent.

The side-hills were covered with a growth of deer-oak and manzanita, white, and red fir, cedar, and yellow pine. Of the cedar there were some especially fine old trees. There was an abundance of water coming down in small streams on both sides of the main creek, and that element always makes for plentiful bird and mammal life. The list of mammals included the golden-mantled ground squirrel, two species of chipmunks, flying squirrel, snowshoe rabbit, *Zapus,* and marten. Birds were plentiful, both near camp and in the woods, among them being Lincoln sparrow, Lewis woodpecker, ruby-crowned kinglet, and creeper. The locality may be considered as prevalently Canadian in zone.

Mount Eddy is a bare, cone-shaped peak, 9151 feet in elevation, next to Shasta the highest point in the region. But, because of the lack of snow and its ruggedness, it does not give one the impression of great height. We made the ascent August 14 by way of Deadfall Cañon and experienced no hard climbing at all, but found it undesirable to stay long on the summit on account of the violent wind that was blowing. The southwest side of the peak is well timbered with foxtail pine, and a few straggling white-bark pines reach almost to the barren summit, which is covered with loose shale rock. There was a small bank of snow on the north side. We got a good view of the Salmon Mountains, and counted eight ridges between us and Lassen Butte. Mount Shasta looked stupendous, but the view toward the Sacramento Valley was unsatisfactory on account of the haze. We saw some nutcrackers and vireos near a small lake about 500 feet below the summit, and

almost at the top I heard a chipmunk. We collected a number of botanical specimens, mostly species of the Canadian and Hudsonian zones.

We spent August 12 at Toad Lake, Siskiyou County, which is across the divide, south, from Bear Creek. In making the ascent to the divide we passed through a forest of young silver pine, and on the summit saw a much-branched white-bark pine. The lake is circular, several acres in extent, and has an underground outlet which is the source of one of the western branches of the Sacramento River. On the eastern side is a tundra-like marsh with tamrac pines growing along the edge. Other trees around the lake are silver pine, red and white fir, Jeffrey pine, and hemlock. The south wall of the basin has no timber and is very rocky.

Castle Lake.—On August 17 we left Bear Creek and, after crossing the divide at its head, followed the North Fork of the Sacramento in to Sisson. John Baker left us here, and the next day we secured a wagon and went to Castle Lake, a favorite summer camping place for the people of Sisson. This lake lies at an altitude of 5434 feet, about twelve miles southwest of Sisson. There are a few trees left in their natural state around the lake and for a mile or so down the cañon from it, but over all the rest of the country between it and Sisson the timber either has been cut or is in process of being cut, and I believe this in part accounts for the strange mixture of life-zones that we found there. The eastern slope of the lake is sparsely wooded with white fir, and tamrac, yellow and silver pine, trees belonging to the Canadian zone, while the western side is a brushy hill covered with chaparral of plum, currant, ceanothus, manzanita, and spiraea. The south side is a wall of granite and broken rock slides, precipitous and forbidding. It was on these rock slides that we caught a bushy-tailed wood rat, and a dark bit of fir woods produced a flying squirrel. Golden-mantled ground squirrels lived on the dry side-hill, and the common ground squirrel of the lowlands *(Citellus douglasii)* was taken where the creek leaves the lake. Two unusual forms also taken here were *Evotomys* and the least weasel.

Considered from the zonal point of view, this seemed about the strangest association of mammals that one could encounter. It is probable that in altitude and original state the locality belonged to the Canadian zone. The cutting of the timber raised the temperature and lessened the fall of rain and snow so that animals

of the Transition zone gradually worked up from the valley; and yet the higher zone forms are not yet altogether crowded out. It is only a question of time, it would seem, before the locality will become more purely Transition. At any rate, Castle Lake proved an interesting collecting point and made a good finish for our trip, which terminated at Sisson on August 23.

CHECK LIST OF THE MAMMALS

1. Scapanus latimanus latimanus (Bachman).
2. Neurotrichus gibbsi major Merriam.
3. Sorex vagrans amoenus (Merriam).
4. Sorex montereyensis montereyensis Merriam.
5. Myotis longicrus longicrus (True).
6. Lasionycteris noctivagans (LeConte).
7. Eptesicus fuscus fuscus (Beauvois).
8. Ursus americanus Pallas.
9. Canis lestes Merriam.
10. Urocyon cinereoargenteus townsendi Merriam.
11. Bassariscus astutus raptor (Baird).
12. Procyon psora pacifica Merriam.
13. Martes caurina caurina (Merriam).
14. Martes pennanti pacifica (Rhoads).
15. Mustela muricus (Bangs).
16. Mustela saturata (Merriam).
17. Mustela vison energumenos (Bangs).
18. Spilogale phenax phenax Merriam.
19. Mephitis occidentalis occidentalis Baird.
20. Felis oregonensis oregonensis Rafinesque.
21. Lynx fasciatus Rafinesque.
22. Reithrodontomys megalotis klamathensis Merriam.
23. Peromyscus maniculatus gambelii (Baird).
24. Peromyscus boylii boylii (Baird).
25. Peromyscus truei gilberti (Allen).
26. Neotoma fuscipes fuscipes Baird.
27. Neotoma cinerea occidentalis Baird.
28. Evotomys obscurus Merriam.
29. Microtus montanus montanus (Peale).
30. Microtus californicus californicus (Peale).
31. Microtus mordax mordax (Merriam).
32. Thomomys leucodon navus Merriam.
33. Thomomys monticola pinetorum Merriam.
34. Dipodomys californicus trinitatis, subsp. nov.
35. Zapus trinotatus alleni Elliot.
36. Aplodontia chryseola Kellogg.
37. Citellus douglasii (Richardson).
38. Eutamias amoenus amoenus (Allen).
39. Eutamias senex (Allen).

40. Callospermophilus chrysodeirus trinitatis Merriam.
41. Sciurus douglasii albolimbatus Allen.
42. Sciurus griseus griseus Ord.
43. Glaucomys sabrinus flaviventris Howell.
44. Lepus washingtonii klamathensis Merriam.
45. Lepus californicus californicus Gray.
46. Sylvilagus bachmani ubericolor (Miller).
47. Odocoileus columbianus columbianus (Richardson).

GENERAL ACCOUNTS OF THE MAMMALS

Scapanus latimanus latimanus (Bachman)

Central California Mole

One skull (no. 12996) was picked up at Tower House, and one skin-with-skull (no. 13798) was secured at Scott River. The latter, a male, measures as follows: total length, 165 millimeters; tail vertebrae, 35; hind foot, 21.

Neurotrichus gibbsi major Merriam

Large Shrew-Mole

The two specimens (nos. 12908, 12909), which we obtained at Tower House, are placed under this subspecies since both in measurements and in the presence of an anterior cusp on the cingulum of the upper premolar they correspond to the description (Merriam, 1899, p. 88). There is considerable difference in elevation between the type locality of *N. g. major*, Carberry Ranch, Shasta County, altitude 4100 feet, and Tower House, altitude 1200 feet. The former locality is in the upper part of the Transition zone, the latter in high Upper Sonoran.

Sorex vagrans amoenus (Merriam)

Sierra Nevada Shrew

Shrews were not common at any of the points where we collected. A series of sixteen of this form was secured (nos. 13780-13795), seven of them taken at Mayten, Siskiyou County, our lowest camp. Other localities where they were found are: Castle Lake, Siskiyou County, two; Salmon River, Siskiyou County, three; Rush

Creek, Siskiyou County, three; and Bear Creek, Trinity County, one.

Average measurements of seven specimens from Mayten are as follows: total length, 98.8 millimeters; tail vertebrae, 38.4; hind foot, 12. Average of nine from other localities: total length, 98.5; tail vertebrae, 38.4; hind foot, 12.3.

Sorex montereyensis montereyensis Merriam

Monterey Shrew

Four specimens of this shrew were taken, three at Tower House, Shasta County (nos. 12906, 12907, 12997), one at Castle Lake, Siskiyou County (no. 13797), and one at Jackson Lake, Siskiyou County (no. 13796). Average measurements of four of these: total length, 112 millimeters; tail vertebrae, 48.7; hind foot, 13.

Myotis longicrus longicrus (True)

Long-legged Bat

There is nothing quite so wasteful of ammunition as shooting at bats. At Kangaroo Creek and Castle Lake we used to spend the evenings until dark trying to hit the wavering, fluttering things. The time for shooting was limited because the bats would not come out until the light was nearly gone; this accounts in part for the few secured. Two specimens of the above species (nos. 13804, 13805) were taken at Castle Lake, August 22.

Lasionycteris noctivagans (Le Conte)

Silver-haired Bat

Two specimens were gotten at Kangaroo Creek, August 4 (nos. 13802, 13803); these are evidently young, though they were well able to fly.

Eptesicus fuscus fuscus (Beauvois)

Large Brown Bat

Two specimens taken at Kangaroo Creek, August 3 and 4 (nos. 13799, 13800), and one at Castle Lake, August 19 (no. 13801).

Ursus americanus Pallas

Black Bear

The region around Callahan, Siskiyou County, and from there westward through the mountains as far as we went, is one in which, according to common report, black bears are still fairly numerous. At Callahan we were told how men went out with dogs in the winter and without having gone any great distance would return bringing a bear. We saw some good-sized skins for sale there, and Miss Alexander purchased two (nos. 13765, 13766) in good winter pelage, but without skulls.

At Jackson Lake we saw some old sign; but it was not until Hunters' Camp was reached, on our way up Grizzly Creek, that we were told we were in the heart of the bear country. It certainly began to look like it, when John Howard took his rifle and within a few minutes walk of camp saw a bear ambling along among the trees. It had not scented him, so was going leisurely and he had a good shot. The bear was left all night where it fell, with a coat thrown over it; for, according to the hunters, coyotes will not touch anything which has any article of clothing left around it. This bear, a female, was not a large individual, possibly two years old. It was saved as skin and complete skeleton (no. 13764).

Subsequently, a skin and complete skeleton (no. 14712) taken near Callahan, October 7, 1911, was sent to the Museum by J. Baker.

Canis lestes Merriam

Mountain Coyote

When we were at Helena, George Knowles reported seeing many tracks of coyotes, but he did not secure any specimens. However, he later sent in a skin and skull (no. 12876) from Hay Fork. There is evidence that the two do not belong to the same animal, since the skull showed considerable weathering, while the skin was fresh. At any rate, the same locality is doubtless represented.

The skin shows no significant characters in either size or coloration; measurements (by collector): total length, 1040 millimeters; tail vertebrae, 305; hind foot, 178; height of ear, 89. The skull, however, differs somewhat from typical *Canis lestes*, and if more material were available to bear out the points, it would appear that we had at last found indications of a northwest-coast race of coyote.

Compared with a skull of *Canis lestes*, this skull shows only a very slight development of the deuterocone on P^4, the teeth are extremely massive and more crowded and the auditory bullae are larger and more inflated. Such characters would constitute good ground for specific differentiation if found repeated in several specimens.

During the summer we secured only one coyote, too young to be of any value for comparison (no. 13763). Our guide, Mr. Baker, saw fresh tracks on our trip up Wildcat Peak, at Jackson Lake, and confidently set some steel traps, baited with grouse, but he caught nothing. For the most part we were not in country where we should expect to find them, it being too high and mountainous. During our stay at Helena, Knowles reported seeing many coyote tracks and said that they bothered him by digging out and springing his steel traps set for other animals.

Urocyon cinereoargenteus townsendi Merriam

Townsend Gray Fox

At Helena foxes seemed to be abundant. Knowles secured seven in all (nos. 12879-12885), by trapping. The weights of these varied from 4½ to 10½ pounds. We bought two skins, without skulls, from D. M. Corliss at French Gulch, Shasta County (nos. 12877, 12878). In the Trinity and Salmon mountains we saw no sign of foxes.

In the series obtained, and which are otherwise referable to this form, the white stripe on the hind leg is quite well defined, although Merriam, in his description of *townsendi* (1899, p. 103), says: "The white stripe on the hind foot of *californicus* has disappeared and is represented by a pale streak."

Bassariscus astutus raptor (Baird)

California Ring-tailed Cat

All four specimens (nos. 12886-12889) of this species were taken at Helena, Trinity County. We might have found them at Tower House, too, but the weather while we were there was stormy and we did not devote much time to the setting of steel traps. George Knowles trapped three of the civet cats, and Miss Alexander and I, after a good deal of maneuvering, managed to trap one. We had

seen the tracks of a small animal in the sand along the river and, by taking an imprint of the foot of one of Knowles' specimens as a pattern, had decided they pertained to a civet cat. We set a number 1 steel trap under a willow tree, hanging the bait from a branch. The first night the animal climbed the tree, got out on the branch and dragged the bait over a side branch toward it. The second night we hung the bait farther out and nearer the ground, and cut off the side branches. The additional effort proved successful.

The largest specimen taken by Knowles (male, no. 12889) measured: total length, 720 millimeters; tail vertebrae, 340; hind foot, 70; ear, 45. Its weight was two pounds.

Procyon psora pacifica Merriam

Pacific Coon

Our specimens (nos. 12890-12894), three from Helena, one from Hay Fork and one from Tower House, all belong to this dark form of *Procyon* (see Merriam, 1899, p. 107). The saying "cunning as a coon" was exemplified in the case of one we finally trapped at Helena; but it was perhaps more because of our way of fixing the trap than of much cunning on the part of the animal that he was able to take our bait two nights in succession. We were trying a trap called "Stop-thief", which is supposed to catch the animal around the head, this being more humane than the common steel trap; but on account of its mechanism the animal had to step through it, so we arranged a cave of rocks with the bait inside and the trap at the entrance. The first morning after setting we found the remains of the bait, a saw-bill duck, about two yards away from the cave with the trap attached. It had been dragged through the entrance. The next morning the coon had torn the cave open from the opposite side. So we gave up the "Stop-thief", and readily caught the coon the following night in an ordinary steel trap, with suspended bait.

We saw no signs of coons in the higher mountains of the Salmon and Trinity ranges. Neither were any tracks seen at Scott River.

Martes caurina caurina (Merriam)

Northwestern Pine Marten

We secured seven specimens of marten (nos. 13767-13773), one at Jackson Lake, three at the head of Rush Creek, and three at the

head of Bear Creek. I have designated them as *Martes caurina*, although they are not typical of that form as represented by specimens in the Museum collection from Vancouver Island, British Columbia. Our specimens show both summer and winter pelages and in both instances the markings of the throat and under surface are not an orange red, as in the Vancouver specimens, but more of a yellow, and the whole body color is much paler. They also differ from the Vancouver specimens in having the metaconid of the lower carnassial more distinct. A female taken at Crescent City is described by Merriam (1890, p. 27) as being of a uniform light seal brown with yellowish markings. It thus appears that that individual together with our specimens represents an extreme southern type of *Martes caurina*.

Our no. 13772, male, in fresh fall pelage, has the center of the back raw umber shading to tawny olive on the sides; underfur wood brown. The underparts are tawny olive sprinkled with white hairs; markings of the throat, deep chrome. The ears are drab with a whitish edge; the nose vandyke brown. The front feet shade from Prouts brown to bistre. The tail is darker than the back; the brush seal brown. In another specimen, with worn pelage, the underfur of the back shows in patches vandyke and wood brown, and the throat markings have faded to maize yellow.

Our first specimen was taken at Jackson Lake at the foot of a rock slide on the east side of the lake. It was caught only by the side pad of one front foot, but so securely that the trap held in spite of the fact that the animal had gotten down below the rock where the trap was set and had crawled into a hole. At Rush Creek we caught one in a trap set under a big log in a dense grove of firs on the sidehill near a small stream, and the other two, evidently a pair, close together, out of six traps we had set up the cañon of a small stream leading into a lake. Here also the timber was dense. At Bear Creek we found martens in much the same situation among the timber and near water and I had the pleasure of seeing one running along a log, but he saw me first and his disappearance was rapid.

Martes pennanti pacifica (Rhoads)

Pacific Fisher

Knowles reported one day at Helena that a fisher had been around to all his traps, which were set on a ridge, and eaten the

bait. He had to dig the traps out of the snow, which had fallen since his previous round, and set them again, confident that he would catch the fisher; and he succeeded. He told us this specimen (no. 12901) showed a somewhat lighter tone of coloration than he had seen in other individuals. Before leaving Helena, Miss Alexander purchased a fisher skin (no. 12902) which had been taken about six miles from Helena in 1910.

Our next information in regard to the presence of fisher came from Jack Hinz at Summerville, Siskiyou County, on the Salmon River. He said he had often trapped them on ridges near his place. The night that we spent on the divide between the Salmon River and Grizzly Creek, at Hunters' Camp, Hinz set some traps for fisher, but his efforts here, and afterwards at the head of Grizzly Creek, were unsuccessful. He stated that the animals were much more difficult to catch in summer than in winter. The Museum collection has since then been enriched by four more specimens (nos. 16386, 16531, 16596, 19095), taken by Hinz near Cecilville, December 13, 1911, February 19, 1912, March 25, 1912, and January 27, 1913, respectively.

Description of the winter pelage follows: Above, from between ears to middle of back, buffy yellow shaded with black; an irregular black streak from middle of back to base of tail; sides cinnamon; general effect of tail black with background of vandyke brown; nose to eyes seal brown; underfur of head and neck vandyke brown, of back, hair brown; head grizzled with grayish white; throat blackish seal brown, darker on breast and belly; legs and feet black. In worn pelage: Above yellowish white to middle of back; black stripe more restricted; sides tawny olive; underparts lighter.

Measurements in Millimeters of *Martes pennanti pacifica* from Northern California

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Hind foot	Ear
12901	♀	Helena, Trinity Co.	830	340	90	35
16386	♀	Cecilville, Siskiyou Co.	864	375	88.5	50.5
16531	♂	Cecilville, Siskiyou Co.	997	381	114	50.5
16596	♂	Cecilville, Siskiyou Co.	991	368.5	120.5	50.5
19095	♀	Cecilville, Siskiyou Co.	864	349.5	101.5	38

Mustela muricus (Bangs)

Sierra Least Weasel

Of this tiny and apparently little known weasel we secured two specimens (nos. 13776, 13777), one at the head of Rush Creek, Siskiyou County, at an altitude of 6400 feet, and the other at Castle Lake, Siskiyou County, altitude 5434 feet. The first one was caught in a number 1 steel trap set under a log on the margin of a small lake. The one at Castle Lake came to oatmeal bait on a rat-trap set in a clump of firs where we were trapping for flying squirrels.

The two specimens agree with the description of *muricus* by Bangs (1899, p. 71) except for the tail of one, which is nearly all white but with the tip dark and with the upper basal half of the same color as the back. As this specimen also shows spots of white on the nose, behind the ears and on the upper flanks, it may be inferred that the species turns white in winter and that this individual had not fully completed its summer molt. The date of capture, July 28, however, is late for retention of even remnants of the winter pelage. The second specimen was taken August 20; close scrutiny of this one discloses a few white hairs in the tail, and two or three in the back.

The measurements of the two specimens are as follows: No. 13776, ♀, total length, 210 millimeters; tail vertebrae, 55; hind foot, 27; no. 13777, ♀, total length, 205; tail vertebrae, 51; hind foot, 27.

Mustela saturata (Merriam)

Siskiyou Weasel

Two specimens taken at Jackson Lake (nos. 13778, 13779) have been referred to this species, although as far as known this is the first record of its occurrence south of the type locality, Siskiyou, Oregon. There are no white facial markings. At the corner of the mouth is a distinct brown spot considered as characteristic of the species, and in general coloration the specimens otherwise correspond with the first published description (Merriam, 1896, pp. 21-22).

Measurements of the specimens, both male, are as follows: No. 13778, total length, 412 millimeters; tail vertebrae, 136; hind foot, 50; no. 13779, total length, 403; tail vertebrae, 150; hind foot, 43. These average smaller than the two males from the Siskiyou Moun-

tains, Oregon, the average measurements of which as given by Merriam are: total length, 423; tail vertebrae, 164; hind foot, 48.

Mustela vison energumenos (Bangs)

Pacific Mink

Two specimens were taken by us, one at Jackson Lake, Siskiyou County (no. 13774), and one on Coffee Creek, Trinity County (no. 13775), while three (nos. 12903-12905) were sent in later from Hay Fork, Trinity County, by George Knowles. The one secured at Jackson Lake was a female in extremely poor condition, thin, blind in one eye, and with an abnormal growth in the intestinal tract. The female caught on Coffee Creek, July 4, had borne young ones recently. Both of our specimens are darker than the ones from Hay Fork; the latter show a better defined mid-dorsal stripe. But the worn pelage of the two females precludes any accurate comparison of their coloration with that of other material at hand.

Spilogale phenax phenax Merriam

California Spotted Skunk

One specimen of this small skunk was taken at Helena (no. 12900). The teeth are much worn and the lower canines look somewhat deformed. The inner cusp of the upper carnassial is almost lacking. On geographical grounds we might expect to find *Spilogale phenax latifrons* here; but the less prominent black areas of the specimen place it under *phenax* proper.

Mephitis occidentalis occidentalis Baird

Northern California Striped Skunk

Three specimens (nos. 12895-12897) were secured while we were at Helena and two sent in later by George Knowles from Hay Fork (nos. 12898, 12899). The specimens average small in measurements, especially of the hind foot; only one approaches the measurement of the type in that regard, but the discrepancy may possibly be due to the method of measuring, so I have placed them without question under the above name.

Felis oregonensis oregonensis Rafinesque

Northwestern Cougar

One specimen (skin and skull, no. 12871) of mountain lion was gotten by George Knowles at Hay Fork, Trinity County, and sent in after our return.

Lynx fasciatus Rafinesque

Barred Wildcat

As the status of the various species of *Lynx* seems to be rather uncertain I have referred our specimens (four from Helena and Tower House, nos. 12872-12875) to the species first described. They certainly belong to the *fasciatus* group, if that name is to be applied to the more northern form of *Lynx*, rather than to the lighter-colored *californicus* from the south; but they are not as dark as some specimens in the Museum collection from Humboldt Bay. As no specimens of *Lynx fasciatus pallescens* are available for comparison I would hardly venture to identify ours with that form, even though Merriam (1899, p. 104) refers specimens taken on Mount Shasta to it. An adult male taken at Helena weighed nineteen pounds.

Reithrodontomys megalotis klamathensis Merriam

Klamath Harvest Mouse

It was not our good fortune to secure the harvest mouse from Mayten, the type locality. Our camp there was rather unfortunately situated in a dry rocky pasture and we were not conveniently near to the hayfields where we might have found the species. But three specimens from Scott River (nos. 13360-13362), and five from Tower House (nos. 12788-12792) have been referred to this form because of skull characters. The large skull, heavy rostrum, wider brain-case and relatively smaller bullae serve to distinguish our specimens from *R. m. longicaudus*. But the coloration is practically as dark as in *longicaudus*, so that our specimens might best be considered intermediate, and nearest *klamathensis*. The hind foot of four male specimens averages but 17 millimeters, as against an average of 18.5 for two adults from the type locality of *klamathensis*, as given by Merriam (1899, p. 93). One male (no. 12788) measures: total length, 147 millimeters; tail vertebrae, 77; hind foot, 18;

ear, 11.5; but this is no older, as shown by the teeth, than some of the smaller ones.

Note: Since the above was written, Howell's *Revision of the American Harvest Mice* (1914) has appeared, in which the name *klamathensis* is put into the synonymy of *longicaudus*. This ruling does not seem to properly dispose of the case, for the Museum of Verebrate Zoology contains material which points strongly towards the existence of a distinguishable race in northeastern California. This form does not appear to be merely an intermediate stage between *longicaudus* and *megalotis*, as Howell asserts. The cranial characters, as above specified, are too prominent to ignore, and, in combination with color, seem to be of diagnostic value.

Peromyscus maniculatus gambelii (Baird)

Gambel White-footed Mouse.

This white-footed mouse was in evidence at all the camps visited during the summer, and was also taken at Helena. A series of forty-one in all was secured (nos. 12745-12759, 13334-13359), representing the following localities: Helena, Tower House, Mayten, Scott River six miles northwest of Callahan, Jackson Lake, Wildcat Peak, north fork Coffee Creek, Saloon Creek divide, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, Castle Lake. The specimens are variously intermediate in characters between *P. m. gambelii* and *P. m. rubidus*, averaging a trifle nearer the former.

Peromyscus boylii boylii (Baird)

Boyle White-footed Mouse

Taken only at Helena and Tower House (nos. 12760-12779), and not found at any of the summer camps, although it was to have been expected at the localities of low altitude.

Peromyscus truei gilberti (Allen)

Gilbert White-footed Mouse

With the exception of one specimen from Mayten, Siskiyou County (no. 13333), this mouse also is represented only from Helena and Tower House, where eight specimens were secured (nos. 12780-12787).

Neotoma fuscipes fuscipes Baird

Dusky-footed Wood Rat

Most of our specimens of this animal came from Helena and Tower House, although the species was found to occur also at Scott

River and Kangaroo Creek. Most of our summer camps were evidently above the level of their range. Nineteen specimens (nos. 12812-12822, 13383-13390) were secured at the four localities named above.

Neotoma cinerea occidentalis Baird

Western Bushy-tailed Wood Rat

The bushy-tailed wood rat was not common at any of our camps, except that on the North Fork of Coffee Creek. Here Miss Alexander found a colony in a deserted cabin and specimens were trapped without any particular difficulty. At Jackson Lake where we found them first we looked for fresh sign in the rock slides at the south and west sides of the lake without success; but there was plenty of old sign, and rat-traps baited with bacon produced seven in all. The altitude at Coffee Creek was rather low for the species, as was also that at Kangaroo Creek, near Scott River. At the latter place, however, we again found them inhabiting an old cabin and this time in company with their round-tailed kin.

At Castle Lake we did some intensive trapping for what seemed to be the only individual at the Lake. We set a quantity of traps in rock slides at the end of the lake with no success until one morning Miss Alexander found a hind foot left in one of her traps. Since this proved the presence of the species we kept up the trapping and on our last morning she captured the rest of the rat—unmistakably the same animal, for he was minus a hind foot. This we had saved and so, by fastening it in its proper place, were able to preserve a complete specimen.

Twenty examples were secured (nos. 13363-13382), from the following localities: Jackson Lake, North Fork of Coffee Creek, head of Grizzly Creek, Kangaroo Creek, and Castle Lake.

Evotomys obscurus Merriam

Dusky Red-backed Mouse

Owing to lack of material for comparison it is rather difficult to determine the systematic status of the two specimens of *Evotomys* which we secured, one rather young male from Jackson Lake and one adult female from Castle Lake; but the two points in which these incline most strongly to the above-named species are the dull color

and the arched dorsal line of the skull in contrast to the conditions in *E. mazama*, which species is described (Bailey, 1897, p. 132) as being bright-colored and with a notably flat-topped skull. Our specimens agree with *obscurus* also in the basilar length of the skull and in the zygomatic and mastoid breadth. In external measurements our examples do not agree with *obscurus* so well, at least with the published measurements of the type of *E. obscurus;* but in a species of which so few individuals have been taken some latitude may be allowed in this respect. Our specimens measure as follows: no. 13392, ♀ adult, total length, 147 millimeters; tail vertebrae, 43; hind foot, 20. No. 13391, ♂, total length, 137; tail vertebrae, 40; hind foot, 19.5. The type specimen of *obscurus* measured (Merriam, 1897*a*, p. 72) total length, 155 millimeters; tail vertebrae, 47; hind foot, 17. Thus we see that our two specimens average smaller in total length and that of tail vertebrae, but have a longer hind foot. In this latter respect they incline toward *E. mazama*, in four specimens of which according to Merriam (1897*a*, p. 72) the hind foot measured 18.75 millimeters.

Both of our specimens were taken in dark shady places among the pines, in traps baited with oatmeal.

Microtus montanus montanus (Peale)

Peale Meadow Mouse

One specimen (no. 13404), from Mayten, Siskiyou County.

Microtus californicus californicus (Peale)

California Meadow Mouse

This meadow mouse was only taken at our two lowest summer camps, Scott River and Mayten, and in winter at Helena and Tower House. It was not at all common at Scott River, which was rather a wet place, but the dry grass in the other localities was, as usual, full of their runways. Thirty-three specimens were secured: nos. 13393-13404, 13405-13407, 12793-12811, from Helena, Tower House, Mayten and Scott River. The Helena series is perceptibly darker in tone of coloration than the specimens from elsewhere.

Microtus mordax mordax (Merriam)

Cantankerous Meadow Mouse

A series of seventy-one specimens (nos. 13408-13476) of this

long-tailed mountain meadow mouse was taken, the species proving common at all the higher camps except Castle Lake. We found them in damp meadows where they seemed to favor especially patches of hellebore with green grass growing between. No difficulty was experienced in trapping them where their runways and cuttings were much in evidence. Localities of capture are as follows: Jackson Lake, Saloon Creek divide, south fork Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, and Castle Lake.

Thomomys leucodon navus Merriam

Red Bluff Pocket Gopher

Comparatively few specimens of this species were taken, the greatest number being twenty-six from Helena (nos. 12823-12848), with five from Tower House (nos. 12849-12853). During the summer they were found at only one locality, Gazelle, Siskiyou County, where six specimens were taken (nos. 13477-13482).

The *leucodon* group is a distinct one, easily distinguishable in skull characters from its nearest relative, *laticeps*, by the whiteness of the incisors and the fact that they project more strongly forward, and by the smallness of the molars. Considerable difficulty was experienced in deciding from the published description whether or not the subspecies *navus* is a well-marked form and if so, whether our specimens belonged to it or to *leucodon*. *Navus* is described (Merriam, 1901*a*, p. 112) as being a much smaller form than *leucodon;* but a series of topotypes from Red Bluff, in the collection of the Museum of Vertebrate Zoology, shows some individuals so large as rather to eliminate size as a dependable point of distinction. Through the kindness of Mr. Henry W. Henshaw, Chief of the Biological Survey at Washington, some topotypes of *leucodon* were loaned the writer for comparison, and between the two sets of topotypes well-marked differences were seen to exist in skull characters. The comparison further indicated that the specimens from Helena and Tower House, which we have put under *navus*, are somewhat intergradient toward *leucodon*.

The coloration of specimens from Helena and Tower House in winter pelage is as follows: Above, general color bistre; lighter on sides, shading into color of underparts, which extends well up onto the sides. Underparts varying from creamy white to buff,

the slate black bases of the hairs forming a distinct dark background. Nose and region around mouth dark seal brown; throat patches, when present, and inside of pouches, white.

Coloration of specimens from Gazelle, Siskiyou County, in summer pelage is as follows: Middle of back fulvous brown, brightening into fulvous on the sides; face slightly darker than back. Underparts tawny ochraceous, except the throat and sides of head, which are bright fulvous; patches at sides of mouth seal brown; throat patch and inside of pouches white.

Thomomys monticola pinetorum Merriam

Trinity Pocket Gopher

This name seems to be applicable to a slightly marked subspecies ranging west from Mount Shasta through the higher parts of the Trinity region. As far as coloration goes I cannot say that there is much difference between *Thomomys monticola monticola* and *T. m. pinetorum*, although the latter may be considered a trifle brighter; but in skull characters, series of the two are for the most part distinguishable. The best skull character of *monticola* is the shape of the interparietal, which is about twice as broad as it is long; in *pinetorum* the interparietal is only slightly broader than its length. One point emphasized in the original description of *pinetorum* (Merriam, 1899, p. 97) is that the zygomata are much more widely spreading than in *monticola*. Our specimens do not seem to bear this out; but they do show much more distinct temporal ridges, and this we may consider a diagnostic feature of the subspecies.

A series of 182 specimens was procured (nos. 13483-13664), from the following localities: Scott River, Jackson Lake, Saloon Creek divide, North Fork of Coffee Creek, Coffee Creek, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, Castle Peak. A series of fourteen males from Rush Creek averages: total length, 210.5 millimeters; tail vertebrae, 58.7; hind foot, 28.

The coloration of a specimen from Jackson Lake in worn winter pelage may be described as dark fulvous above; the colored ends of the hairs entirely worn off in places, leaving patches of slate black; underparts light ochraceous; nose and mouth parts seal

brown; a black patch around the ear. Specimens in summer pelage are lighter fulvous above, with the dark bases of the hairs not as prominent; underparts varying from ochraceous to light buff; feet and tail whitish. Very few of the specimens are in good pelage, the majority being in ragged transition state from winter pelage to summer, or back again to winter, apparently, before the whole summer molt was completed. The impression gained was that gophers living in cultivated fields, for instance, of alfalfa, accomplish their molts much more completely than animals living in wild land, which, except in summer, are harder put to it to obtain food.

Our largest series of *pinetorum* was secured at Rush Creek. It was while trapping there that we decided that gophers are sensitive to smell, for traps set with bare hands were not so liable to catch anything as those set with gloved hands and the hole excavated with a trowel. Miss Alexander successfully tried baiting the traps by covering them and the entrance to the hole with a species of mint of which the gophers seemed to be fond. With these methods the animals were easily caught. At Jackson Lake we were particularly struck by the winter workings of the gophers. The snow was just off the ground and there had been as yet no cattle around to trample down the innumerable serpentine ridges which covered the open ground and extended even among the shrubbery under the pine trees. These ridges, or "earth plugs", consist of the earth which in winter is pushed up into the snow from underground passages, and they prove the continued activity of the gophers even during cold weather.

Dipodomys californicus trinitatis, new subspecies

Trinity Kangaroo Rat

Type.—Male adult; no. 12860, Mus. Vert. Zool.; Helena, Trinity County, California, altitude 1405 feet; February 18, 1911; collected by A. M. Alexander; original no. 1159.

Subspecific characters.—As compared with *Dipodomys californicus californicus*, coloration dark; thigh patches small; nasals long and heavy anteriorly.

Coloration.—Upperparts from between ears to band across thigh, bistre, suffused with dark buff yellow, brightening into

orange buff on the sides, and somewhat lighter between eyes; thigh patches small, same color as back, darkening towards ankle; supra-orbital white spot distinct; black ring around eye; white spot on upper edge of ear; line over nose and at base of whiskers black; upper portion of feet white, beneath seal brown; upper and lower tail stripes seal brown, the upper merging into black some distance in front of the white pencil. Underparts pure white.

Measurements.—Of type, total length, 310 millimeters; tail vertebrae, 194; hind foot, 46; height of ear, 14. Length of nasals, measured along median line, average of 12 adult males, 14.7 millimeters, average of 3 adult males of *D. californicus,* 13.5; average of 10 adult females of *D. c. trinitatis,* 14.3; average of 5 adult females of *D. californicus,* 13.5. Greatest anterior breadth of nasals, average of 12 adult males of *D. c. trinitatis,* 4.3; average of 3 adult males of *D. californicus,* 3.6; average of 10 adult females of *D. c. trinitatis,* 4.3; average of 5 adult females of *D. californicus,* 3.8.

Discussion.—This new subspecies is based chiefly on the series of fifteen skins (nos. 12854-12868) obtained at Helena. These are in winter pelage, while the 28 specimens (nos. 13665-13692) from Scott River, Siskiyou County, are on account of the difference in season slightly lighter in average coloration. In these the orange buff of the sides is more pronounced, but the skull characters are similar. The series from Helena, compared with topotypes of *californicus,* from Ukiah, Mendocino County, is distinctly darker both in the general color and, more markedly still, in the color of the dark stripes on the tail. The white of the thighs appears restricted and in the dry skins is almost concealed. Such exterior differences, however, are not so convincing as points of difference that can be readily distinguished in the skull, and in the case of this subspecies the length of the nasals and their width anteriorly are well-marked characters.

Another subspecies, *Dipodomys californicus pallidulus* (Bangs, 1899, pp. 65-66), has been described, from Sites, Colusa County; but a study of a series of topotypes of this form in the collection of the Museum of Vertebrate Zoology does not substantiate the subspecies. The characters given for *pallidulus* as compared with *californicus* are: "Color very much paler; thigh patches not dusky; . . . the black markings at base of whiskers and over nose . . . nearly wanting . . . ." A further statement (Elliot, 1901, p.

431) that the tail is "above sepia, beneath white", has no foundation in fact, as the specimens show the regulation two dark stripes, one above and one below, with an intervening white stripe on each side. It is my impression that the specimens from Sites are a trifle lighter than those from Ukiah, especially in the face, but the shade of difference is so slight that I should call them both *californicus* and simply say that individuals from Sites show a tendency toward an extreme of light coloration for the species.

Habitat.—As far as the present geographical distribution of *Dipodomys c. trinitatis* shows, the stock form may have originally worked up over the comparatively low divide from the head of the Sacramento Valley and then differentiated, because of approximate isolation, spreading in like manner to the north and east. George Knowles stated that kangaroo rats occur at Hay Fork, Trinity County; but as far as our present material goes we have no other actual record than those from the two localities at which we collected specimens.

At Helena we trapped for *Dipodomys* on the north side of the Trinity River near its junction with the north fork. For a short distance above this junction small sandy flats extend back from the banks of the river, due partly to hydraulic mining carried on in earlier days. With this exception the river runs through a narrow, rocky cañon, so that it would seem as if *Dipodomys* had here found a very limited area suited to its needs. The area of our trapping did not cover over half a mile, and was confined altogether to the north bank. We crossed the river at one point, about a mile above the junction, but although there was a sandy flat there and conditions seemed to be ideal for *Dipodomys,* we found no signs of them whatever. Where we did trap them, sign was plainly to be seen, consisting of burrows and the tracks of the animals. The prints of the hind feet showed at intervals of about twenty inches, directed to or from clumps of bushes, or around them. These bushes were manzanita and willow, and under them we set our traps. The holes were filled up with sand, evidently by the animals. Trapping was more likely to be successful when done near these holes, even though they did not look as though recently used. Many of the *Dipodomys* secured had succeeded in filling their cheek pouches full of oatmeal before being caught.

Our trapping area at Scott River was not much more extensive

than that at Helena, and was again in sandy ground, in the old bed of the Scott River, but nearly a mile back from the present main stream which, according to report, had been at one time artificially diverted to its present bed. Numerous small creeks and back waters of the river, are, however, on this side of the valley, used for irrigation. Some of the land is under cultivation, but a great deal consists of sand, overgrown with cottonwoods and willows and is used for pasture. The kangaroo rats here seemed to prefer the thicker brush for their headquarters, but Miss Alexander was most successful in securing specimens by setting the traps in a horse trail, to which the animals were no doubt attracted by the grain to be gathered from the droppings.

Zapus trinotatus alleni Elliot

Allen Jumping Mouse

A series of sixty-three specimens of this species was obtained (nos. 13696-13758), from the following localities: Jackson Lake, North Fork of Coffee Creek, Saloon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek. The series is remarkable for the freshness and uniformity of the pelage and the fact that nearly all the specimens are adult. In some groups of mice, such as *Microtus* and *Peromyscus*, nearly as many young ones as adults are taken, but in our trapping we did not take a single very young specimen of *Zapus* in spite of the fact that some of the females showed signs of having bred.

Another rather singular fact was that we never saw any signs of *Zapus*, such as runways, excrement or cuttings, and yet we caught some individuals at every camp where there were meadows or alders along running water, from an elevation of 4500 feet, on the North Fork of Coffee Creek, to our highest camp at Jackson Lake, 7200 feet. The species was most abundant at Coffee Creek, where we secured half of the whole series. We always found them in places where the vegetation was rank, generally, as just stated, under alders.

Aplodontia chryseola Kellogg

Trinity Mountain Beaver

Ten specimens secured (nos. 13324-13332, 13806) from Jackson

Lake, south fork of Salmon River, Wildcat Peak, and head of Grizzly Creek. Upon this series was based the description of *Aplodontia chryscola* as a new species showing nearest affinities with *A. californica* of the central Sierra Nevada (see Kellogg, 1914, p. 295). This species proves to be not closely related to the coast form, *A. phaea,* as its golden brown coloration might seem to indicate. Cranial and other characters lead the writer to conclude that *chryscola* is derived from *californica* stock, the latter thus having invaded the territory westwardly towards the coast through the Trinity region. For cranial characters see table of measurements, page 371, and photographs, plate 18.

Our first systematic search for signs of mountain beaver was begun at Jackson Lake, Siskiyou County. Here clumps of alder grew on sidehills from which trickled small streams of water. This seemed ideal ground for the animal, but the first real sign was found on drier ground where a runway was located between two such groups of alders. The tunnel, or runway, was finally traced direct from one alder patch to the other through a growth of wild plum, and measured seventeen meters in length. There were a dozen or more exposures of the runway. Although it seemed to be continuous, the tunnel proved, upon examination, to be disconnected at about a third of the distance, as it took a decided turn down the hill, while the one in line with it tended diagonally up hill. Before the first section of tunnel took the downward turn there was a small side exit, showing that the animals foraged abroad into the rather open wild plum grove as well as into the alder thickets. There may have been underground connections between the two sections. The first tunnel ran back into the alders, and there was no visible exit within a radius of several yards. The tunnel throughout its exposed length was dry and looked to be in recent use. In hunting among the alders we found several old burrows which now serve as underground channels for small streams.

Miss Alexander found other *Aplodontia* burrows north of Jackson Lake in alders along one of the main tributaries of Jackson Creek. In places the ground was literally honeycombed by them. In such a multiplicity of runways it was hard to select just the right places for the traps. Fresh sign was found near an old fallen tree by the stream. The tree was about forty-five feet long and the main tunnel seemed to run lengthwise underneath it with exits

TABLE OF CRANIAL MEASUREMENTS OF *Aplodontia chryscola* FROM NORTHERN CALIFORNIA

Oldest available specimen of each sex at top of column, youngest at bottom

All measurements in millimeters

Museum number	Sex	Locality	Length of nasals (1)	Width of nasals (2)	Ratio width of nasals to length	Length of incisive foramina (3)	Greatest breadth of interpterygoid fossa (4)	Length of auditory tubes (5)	Basilar length	Ratio length of auditory tubes to basilar length
13331	♂	Head Grizzly Cr., Trinity Co.	22.9	12.3	53.7	6.7	4.9	21.1	61.8	34.1
13328	♂	Jackson Lake, Siskiyou Co.	24.6	13.0	52.8	7.3	5.3	19.8	60.9	32.5
13326	♂	Jackson Lake, Siskiyou Co.	25.1	11.7	46.6	7.6	5.3	19.4	58.6	33.1
13327	♂	S. Fork Salmon R., Siskiyou Co.	25.3	10.8	42.7	7.3	5.1	17.9	58.7	30.5
13329	♂	Jackson Lake, Siskiyou Co.	22.4	10.9	48.6	6.7	5.0	17.2	59.5	28 9
13330	♀	Wild Cat Peak, Siskiyou Co.	24.4	10.8	44.2	6.7	4.9	18.0	57.9	31.1
13324	♀	Jackson Lake, Siskiyou Co.	26.1	12.5	47.9	6.7	5.1	19.5	59.1	33.0
13332	♀	Head Grizzly Cr., Trinity Co.	24.3	11.2	46.1	7.6	5.1	17.8	58.3	30.5
13325	♀	Jackson Lake, Siskiyou Co.	25.1	10.7	42.6	6.7	4.6	16.5	57.7	28.6

[1] Most anterior point on nasal bones to most posterior point.

[2] Greatest width of nasals, across both of them.

[3] With cranium resting on its dorsal surface, rostrum pointing away from the worker, the greatest length of the foramen on the right side.

[4] Taken at expansion of interpterygoid fossa immediately back of hard palate.

[5] Most lateral point on foramen ovale to the point farthest laterally (with reference to the skull) on zygomatic side of auditory tube.

on either side, but chiefly on the water side. Two holes in the ceiling, from the neighborhood of which dirt had been scratched into a pile, exposed a passage way about fourteen inches in diameter. It was damp, but there was no running water in it, as was the case a few feet farther down in the tunnel. The fresh sign consisted in the trampled appearance of the exits, fresh cuttings of grass in them, and the broken leaves of plants at the entrance. Another runway was found with a passage leading up to a large hollow under a rock, the floor of which was strewn with alder cuttings about a foot in length. The branches were generally cut diagonally, and one was as much as half an inch in diameter. The animals seem to well deserve their name of "mountain beaver".

Miss Alexander caught three males in one limited area at Jackson Lake, but on the whole the idea that these animals live in colonies did not seem to be correct. They may do so at certain times of the year, as during the breeding season and until after the young ones are full grown; but we never trapped more than one animal at a single set of burrows.

On the Salmon River we found the mountain beavers making what we called "hay"—large bunches of green plants of various kinds cut up and spread out as if to dry and to be used later. (See pl. 16, figs. 3, 4). On a sidehill down which ran several small streams among alders and poplars there was a collection of burrows more extensive even than any found at Jackson Lake. These were situated both near the stream and out in the more open, drier ground. The runways led under roots and over rocks, with openings at short intervals, and there were plain runs out into the brush where short branches ran from each main tunnel, somewhat like a gopher working, with a dump of earth at each terminus.

Citellus douglasii (Richardson)

Douglas Ground Squirrel

Most of our camps were above the range of this ground squirrel. At Scott River it was common in the sandy ground along the numerous irrigation canals leading off from the river. We caught a good many more individuals than we wanted, especially of young ones. The weather was very warm and their greasy skins slipped quickly. The occurrence of the species at Castle Lake, however,

made them seem a little more desirable; for here they were apparently above the limit of their usual range and were found both on the dry rocky hillside above the lake and in damper ground where the creek came out from the lake; altitude 5434 feet. I presume that until the timber between Sisson and Castle Lake was cut out the ground squirrels were probably not found there. They doubtless followed the steadily retreating timber-line which resulted in unnatural conditions of dryness for such an altitude. The specimens taken at Castle Lake were in the process of molt into fresh fall pelage.

Eleven specimens were taken (nos. 13018-13028), from Mayten, Scott River, Summerville, six miles northwest of Callahan, and Castle Lake.

Eutamias amoenus amoenus (Allen)

Klamath Chipmunk

This small chipmunk was encountered at every camp. Its greatest abundance was at Jackson Lake and on Rush and Bear creeks. Here the timber conditions seemed to be just right for them, and when other material was scarce we could always depend upon the chipmunk. Ninety-six specimens were obtained (nos. 13083-13177, 13280), from the following localities: Scott River, Jackson Lake, Wildcat Peak, Salmon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, head of Deadfall Creek, Castle Lake.

Eutamias senex (Allen)

Allen Chipmunk

We found this larger chipmunk along with the smaller one at every camp, and collected a good-sized series, the bulk of it coming in at Jackson Lake, Bear Creek and Castle Lake. Our specimens differ somewhat from the description of *senex* in having the tail, below, cinnamon rufous, instead of orange; in this respect they incline toward *E. quadrimaculatus*, a form of a lower zone. But their measurements and coloration otherwise identify them unquestionably as *senex*.

One hundred and two specimens were obtained (nos. 13178-13279), from the following localities: Scott River, Jackson Lake, Wildcat Peak, North Fork of Coffee Creek, South Fork of Salmon River,

Grizzly Creek, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, Castle Lake.

Callospermophilus chrysodeirus trinitatis Merriam

Trinity Golden-mantled Ground Squirrel

The distribution of this form is given (Merriam, 1901*b*, p. 126) as "the Siskiyou, Salmon, and Trinity mountains of northwestern California and southwestern Oregon". It is described as being "much larger and darker than *chrysodeirus*, and [it] never, so far as known, develops the golden mantle which covers the head and shoulders of that species". The average measurements of six specimens from the type locality is stated to be "total length, 283; tail vertebrae, 100; hind foot, 43".

On geographical grounds one would expect the golden-mantled ground squirrels of the parts of Trinity and Siskiyou counties covered by our trip to come under this subspecies. Twelve of our specimens, males, from the various localities, average: total length, 269.6 millimeters; tail vertebrae, 96; hind foot, 41.3. An average of four specimens, male, of *C. chrysodeirus* from Mount Shasta, is; total length, 263.7; tail vertebrae, 89; hind foot, 40.7. Seven specimens, male, from near Mount Whitney, east-central California, average: total length, 276; tail vertebrae, 94; hind foot, 41.4. Three specimens, male, from Independence Lake, Nevada County, California, average: total length, 258; tail vertebrae, 78; hind foot, 41.3.

Of the three measurements, that of the hind foot seems to be the most constant, and judging from this feature as an index of size the specimens from these different regions should all be classed under the same species, namely, *chrysodeirus*. Moreover, many of our specimens show a well-developed golden color to the mantle, and, as already stated, *trinitatis* was said to lack this mantle color. On the whole, however, I should say that our series is slightly darker than those from Mount Whitney and Independence Lake, and this, even if other ascribed characters fail, might in itself justify the recognition of a form from the Trinity region. Further study of relevant material, with particular attention to changes of pelage with season, and a greater number of measurements of both body and cranium, may show that there are not sufficient grounds for recognition of a form *trinitatis*.

This squirrel was found most abundant on Saloon Creek divide, where it was the predominating species of mammal, as also at the head of Bear Creek, eleven specimens being taken at each of these localities. Its occurrence at Kangaroo Creek must have been at about the lowest limit of its range. Fifty-four specimens were taken (nos. 13029-13082), from the following localities: Jackson Lake, Wildcat Peak, North Fork of Coffee Creek, Saloon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, and Castle Lake.

Sciurus douglasii albolimbatus Allen

Sierra Chickaree

Twenty-one specimens were taken (nos. 12738-12740, 13280-13298) representing five localities: Helena, Jackson Lake, head of Rush Creek, Bear Creek, and Castle Lake. This shows quite a range of zone from the Transition of Helena to the Boreal of Jackson Lake. Those from Bear Creek and Castle Lake, taken in August, show the light ochraceous-buff beneath, of the summer pelage.

Sciurus griseus griseus Ord

California Gray Squirrel

Helena, Trinity County, was the only locality at which we found gray squirrels, and because of the cold weather there in February they were not particularly in evidence. The seven specimens taken (nos. 12731-12737) bear dates from February 13 to 17.

Glaucomys sabrinus flaviventris Howell

Trinity Flying Squirrel

We secured our first flying squirrel at Jackson Lake in a rat-trap baited with oatmeal and set near the head of our bed. For two nights some creature had startled us by running across our faces. When we found what the intruder was, we looked carefully in all the adjacent red firs for some trace of a nest; but our knowledge of the home and habits of *Glaucomys* received no increment by actual observation during our entire trip.

Only three specimens were taken at Jackson Lake, where it may have been too early in the season for them to be out in numbers.

Coffee Creek was too low for them, but we secured one at the head of Grizzly Creek; while the largest series from any one locality, fourteen, came from Rush Creek. Five from Bear Creek and two from Castle Lake make up the total of twenty-five (nos. 13299-13323). Their occurrence at Castle Lake was one of the remarkable features of that camp; but a thick grove of red fir on a side-hill showed that the squirrels as well as the trees may have been more wide-spread there previous to the time of timber cutting. We always selected a thick growth of firs in which to set the traps, and put them at the bases of the larger trees. We often wished we could see the animals in action, but they were as noiseless and mysterious as their fur is soft and silky.

Our series shows an interesting variation in coloration and condition of pelage. As a whole, it seemed to answer quite closely to the original description of the form *klamathensis* (Merriam, 1897*b*, p. 225), and this name we had accordingly adopted. Recently our series was loaned to the United States Biological Survey where a study of the group is in progress. A preliminary paper (Howell, 1915) announces the separation of the Trinity flying squirrel as a recognizable race, the new name *flaviventris* being applied to it. The type is no. 13,319, Mus. Vert. Zool.; head of Bear Creek, 6400 feet altitude, Trinity County, California; collected August 13, 1911, by Annie M. Alexander; original number 1775.

Lepus washingtonii klamathensis Merriam

Oregon Showshoe Rabbit

One male (no. 13759), presumably adult, and an immature female (no. 13760) were taken at Bear Creek, Trinity County, August 8 and 15, respectively. In coloration and cranial characters the adult specimen agrees closely with the latest published description of *L. w. klamathensis* (Nelson, 1909, p. 107). Hitherto, as far as known to the writer, this rabbit has been recorded only from the vicinity of Fort Klamath, Oregon, and from the central Sierra Nevada of California. Our adult example, in summer pelage, may be described as follows: mixed grizzled fulvous and black above; head and face of the same fulvous but with less black; pectoral collar fulvous with a sprinkling of white; chin, throat, and belly white; a white stripe extending along the upper surface of

the hind leg on the inner side and including the toes. The skull shows the deeply grooved jugal, and small auditory bullae considered distinctive of the species. The post-orbital processes are noticeably long. In total length this specimen measures less than the average given of three specimens from Fort Klamath; but the hind foot is even longer and this may be considered a more dependable index to actual size.

Measurements of this specimen are: total length, 367 millimeters; tail vertebrae, 26; hind foot, 130; height of ear, 87. Average of 3 specimens from Fort Klamath as given by Nelson (1909, p. 108): total length, 414, tail vertebrae, 39; hind foot, 126; ear from notch, 64.

We had been told by Mr. Hinz at Summerville that snowshoe rabbits were frequently seen in that region in the winter and that they were quite abundant on the south fork of the Salmon River. We had seen no sign of them at our camp there, and had decided that only the merest chance would furnish any specimens during the summer season. Our camp at Bear Creek was on the edge of a mountain meadow, and within two hundred yards of our tent was some higher dry ground covered with small brush through which ran innumerable cattle paths. Miss Alexander was making the rounds of her small traps one day about noon, when she scared up a rabbit in this brush. It ran around a bush and then sat perfectly still in the middle of the trail. The creature was so motionless and so nearly the same color as the dried grass of the trail that he could not be seen again until he moved and then he was gone in a flash.

I set a number of small steel traps in the trails under the bushes and baited them with dried apples. The next morning the rabbit was in one of them. The young one was caught in a rat-trap set for squirrels among the trees bordering the meadow. The rest of this family were probably living in the neighborhood, but further trapping failed to secure any more specimens.

Lepus californicus californicus Gray

California Jack Rabbit

Scott River was the only camp at which we saw jack rabbits, and even here they were not especially abundant. They affected the

adjacent hillsides. Two specimens were secured (nos. 13761, 13762). A third was sent in by Mr. Knowles from Hay Fork, Trinity County (no. 12869).

Sylvilagus bachmani ubericolor (Miller)

Redwood Brush Rabbit

Mr. Knowles sent in a specimen (no. 12870) of this race of brush rabbit taken at Hay Fork, Trinity County, in March. We did not encounter it anywhere during the summer collecting.

Odocoileus columbianus columbianus (Richardson)

Columbian Black-tailed Deer

The entire region which we covered, with the exception of Mayten and Scott Valley, is supposed to constitute an excellent deer country; but our experience was that these animals had to be hunted for long and arduously and that big bucks were hard to get. The writer did not personally see a single deer during the whole summer, but the other members of the party were all more fortunate. A total of eight specimens were secured (nos. 13013-13017, 12729, 12730, 13807), from the following localities: North Fork of Coffee Creek, Summerville, head of Grizzly Creek, head of Rush Creek, Helena, Hay Fork, and Callahan.

During our stay at Helena, in February, George Knowles reported seeing a band of twenty-four deer. That was at a time of the year when they would be herding together, and, too, on account of the scarcity of feed, they would then be coming down nearer to human habitations. At Jackson Lake, in June, some men camped below us had seen a doe drinking at the stream, and Miss Alexander jumped one in the brush; also there were many fresh tracks. In spite of several nights spent by the men at the lick, near which we camped, only one young buck was shot. They said a big buck started to come in one night, but it was moonlight and he saw them before they had a chance to shoot. Mr. Baker told us he thought the deer were then feeding by moonlight and lying close in the brush during the day so that they could not be scared up unless nearly stepped upon.

As I have said, each animal secured meant a hard day's tramp over miles of country. The best specimen obtained was at Rush

Creek, a fine buck, with four points to the horns, which were in the velvet. Mr. Baker found a big hole in the body where the animal had been shot before. He says deer often get off with bad wounds, the bullet finally becoming encysted, and the animal apparently suffering no permanent ill effects. The big bucks, he claimed, along towards the end of July, go off by themselves on the high ridges, only coming down for water. The does and young ones stay more in the cañon bottoms. As is often the case in other regions, there are popular theories as to there being several different species of deer, for instance a long-legged kind and a short-legged one. But we failed to secure evidence that would go to show the presence of any true species other than *Odocoileus columbianus*.

LIST OF THE BIRDS, WITH ANNOTATIONS

Actitis macularius (Linnaeus). Spotted Sandpiper. Two adult skins (nos. 19120, 19121), from Jackson Lake, June 18 and 20.

Oxyechus vociferus (Linnaeus). Killdeer. Observed June 4 at Mayten.

Orcortyx picta picta (Douglas). Mountain Quail. Nine specimens (nos. 17299-17302, 19122-19126), from Helena, head of Bear Creek and Castle Lake. Three of these, taken August 15, 16 and 20, are juvenals, and in this plumage the characters distinguishing *picta* from *plumifera* are better shown than in the adult. These characters consist in a warmer brown suffusion dorsally and greater extent of black markings.

Numerous at nearly all of the mountain stations. On July 8, on north fork of Coffee Creek, the writer caught sight of a weasel in pursuit of a mountain quail. The bird was clucking in a distressed manner and evidently leading the enemy away from where her chicks were. When the weasel got her to a safe distance he ran back, jumped over a log, and was seen to make off with a small victim in his mouth. The whole episode did not occupy two minutes and occurred in a clearing in broad daylight.

Lophortyx californica vallicola (Ridgway). Valley Quail. Two skins (nos. 17303, 19127), from Helena and Scott River. A nest

found at the latter point, June 8, contained seventeen eggs. Seven of these occupied the center, while the remaining ten were disposed in an outer row. Observed also at Tower House.

Dendragapus obscurus fuliginosus (Ridgway). Sooty Grouse. Two skins (nos. 17304, 17305), taken at Hay Fork March 20, sent to the Museum by George Knowles. These are not typical *fuliginosus*, but show themselves to be a step nearer to this humid-coast form than the grouse of the localities enumerated under the next heading. The Trinity region evidently constitutes a part of the area of intergradation between *sierrae* and *fuliginosus* proper.

Dendragapus obscurus sierrae Chapman. Sierra Grouse. Eight specimens (nos. 19128-19135), from Callahan, north fork of Coffee Creek, Grizzly Creek, Summerville, head of Rush Creek and head of Bear Creek. One of these is a downy young, taken on July 8; three others are juveniles, taken July 18 and 25 and August 7. The females and young average very slightly browner dorsally and are more heavily marked on the breast than typical *sierrae*, thus indicating intergradation towards *fuliginosus*.

Heard drumming at Jackson Lake the third week in June, and one shot on flanks of Wildcat Peak, June 27. Brood of half-grown young seen July 18, at Summerville, where these birds are said to visit the farmyard occasionally to share the feed with the chickens. A farmer on Kangaroo Creek complained that grouse were so numerous that they were injuring his young grain. At this season, August, the grouse come down off the hillsides and collect around the margins of clearings where they prove locally destructive to crops. Abundant at head of Bear Creek during second week of August.

Zenaidura macroura marginella (Woodhouse). Western Mourning Dove. Nest and two eggs found June 5 at Mayten. A flock noted at Scott River, June 11.

Accipiter velox (Wilson). Sharp-shinned Hawk. One immature (no. 19136), from Castle Lake, August 19.

Accipiter cooperi (Bonaparte). Cooper Hawk. One immature (no. 19137), from Kangaroo Creek, August 3.

Astur atricapillus striatulus Ridgway. Western Goshawk. One adult (no. 17306), from Hay Fork, taken March 26 by George Knowles.

Falco sparverius sparverius Linnaeus. Sparrow Hawk. One

seen on Wildcat Peak, June 29, and a pair seen at Summerville, July 18.

Dryobates villosus orius Oberholser. Modoc Hairy Woodpecker. Eleven specimens (nos. 17307, 19138-19147), from Helena, Scott River, North Fork of Coffee Creek, and head of Bear Creek. This series is on the whole darker on the breast and less spotted than typical *orius*, but not to such a degree as to be referred to *harrisi*, though intergradation in this direction is indicated.

Dryobates pubescens gairdneri (Audubon). Gairdner Woodpecker. Four skins (nos. 17308, 17309, 19148, 19149), from Helena, Tower House, and Scott River. These are not typical *gairdneri*, but tend towards *turati*.

Xenopicus albolarvatus albolarvatus (Cassin). Northern White-headed Woodpecker. Two skins (nos. 19150, 19151), from Kangaroo Creek, and head of Bear Creek, August 4 and 6. Seen also on North Fork of Coffee Creek, July 8.

Sphyrapicus varius daggetti Grinnell. Sierra Red-breasted Sapsucker. Nine specimens (nos. 17310, 17311, 19152-19158), from Helena, Scott River, head of Grizzly Creek, and head of Bear Creek. Six, from the last two localities, July 23 to August 16, are juvenals.

Phlocotomus pileatus abieticola (Bangs). Northern Pileated Woodpecker. One skin (no. 17312), taken at Hay Fork by George Knowles, March 27. One seen at Jackson Lake, June 30, working on a dead pine.

Melanerpes formicivorus bairdi Ridgway. California Woodpecker. Two skins (nos. 19159, 19160), from Scott River, where common.

Asyndesmus lewisi Riley. Lewis Woodpecker. One skin (no. 19161), from head of Bear Creek, August 11. A family of the birds was here observed using as a rendezvous a dead tree standing in an open tract of chaparral.

Colaptes cafer collaris Vigors. Red-shafted Flicker. Eight skins (nos. 17313, 17314, 19162-19167), from Helena, Tower House, Jackson Lake, and head of Bear Creek. At Scott River, June 13, a bird was observed excavating a nest-cavity near the summit of a dead cottonwood. Bill-fulls of fine chips were repeatedly brought to the doorway, and allowed to scatter to the ground immediately about the tree. The bird finally emerged with an *egg* in its bill and flew off with it over the fields. The bird soon returned and resumed work upon the interior of the cavity, as evidenced from

the continual tapping from within. It is to be inferred that the egg was laid before the nest-cavity had reached its proper dimensions, and that the bird viewed the egg in the light of an obstruction, to be gotten rid of at that stage of nest-building. The species was also observed at Kangaroo Creek, August 4.

Selasphorus rufus (Gmelin). Rufous Hummingbird. Five specimens (nos. 19171, 19172), from South Fork of Salmon River, July 14, and nos. 19168, 19173, 19174, July 27, 29 and 30, from head of Rush Creek.

Stellula calliope (Gould). Calliope Hummingbird. Three skins, no. 19175, from Wildcat Peak June 30; no. 19170 from South Fork of Salmon River, July 14, and no. 19169, from Castle Lake, August 20.

Sayornis nigricans (Swainson). Black Phoebe. One skin, no. 17315, from Tower House, March 2.

Nuttallornis borealis (Swainson). Olive-sided Flycatcher. Two skins (nos. 19176, 19177), from head of Grizzly Creek, July 23.

Myiochanes richardsoni richardsoni (Swainson). Western Wood Pewee. Five specimens (nos. 19178-19182), June 9 to July 13, from Scott River, Jackson Lake, and South Fork of Salmon River.

Empidonax trailli trailli (Audubon). Traill Flycatcher. One skin, no. 19187, from Scott River, June 12.

Empidonax hammondi (Xantus). Hammond Flycatcher. Adult male, no. 19183, from South Fork of Salmon River, July 15; juvenile male, no. 19184, head of Grizzly Creek, July 23; juvenile male, no. 19186, Castle Lake, August 20.

Empidonax wrighti Baird. Wright Flycatcher. One juvenal, no. 19185, from head of Bear Creek, August 14.

Cyanocitta stelleri frontalis (Ridgway). Blue-fronted Jay. Nineteen skins, nos. 17316, 17317, 19188-19204, from Helena, Jackson Lake, North Fork of Coffee Creek, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, and Castle Lake. Some of these show indications of intergradation towards the coast form *carbonacea*.

Aphelocoma californica californica (Vigors). California Jay. One skin, no. 17318, from Helena, February 24, where only two or three were noted. Observed also at Scott River, in June.

Nucifraga columbiana (Wilson). Clarke Nutcracker. One specimen, no. 19205, from head of Bear Creek, August 12. Seen at Jackson Lake, June 23 and 24, and on Wildcat Peak, June 28.

Agelaius phoeniceus nevadensis Grinnell. Nevada Red-winged Blackbird. Seven breeding adults, nos. 19206-19212, from Mayten, June 4 and 5. At this locality the species was common on marshy ground around Big Spring. For systematic treatment, see Grinnell 1914, p. 107.

Sturnella neglecta Audubon. Western Meadowlark. Observed June 4 at Mayten, and June 13 at Scott River.

Icterus bullocki (Swainson). Bullock Oriole. Three skins, nos. 19214-19216, from Mayten (June 4) and Scott River (June 11 and 12).

Euphagus cyanocephalus (Wagler). Brewer Blackbird. One skin, no. 19213, from Mayten, June 4.

Hesperiphona vespertina montana Ridgway. Western Evening Grosbeak. One specimen, no. 17319, taken at Weaverville, February 27 (see Kellogg, 1911, pp. 119-120).

Carpodacus purpureus californicus Baird. California Purple Finch. Five skins, nos. 17320, 19220-19223, from Helena (February 24), South Fork of Salmon River (July 14), and Castle Lake (August 21).

Carpodacus cassini Baird. Cassin Purple Finch. One skin, no. 19224, from Jackson Lake, June 18.

Carpodacus mexicanus frontalis (Say). California Linnet. Two specimens, nos. 19225, 19226, from Mayten and Scott River, June 4 and 11. Common at both of these stations.

Astragalinus tristis salicamans (Grinnell). Willow Goldfinch. Two skins, nos. 19227, 19228, from Scott River, June 10 and 11.

Astragalinus psaltria hesperophilus Oberholser. Green-backed Goldfinch. Three skins, nos. 19229-19231, from Scott River, June 11-13.

Spinus pinus pinus (Wilson). Pine Siskin. Four specimens, nos. 17321-17324, from Tower House, March 4 and 7. Seen also at Helena, in February.

Chondestes grammacus strigatus Swainson. Western Lark Sparrow. Three skins, nos. 19232-19234, from Scott River, June 9-11.

Passer domesticus Linnaeus. English Sparrow. Two specimens, nos. 17325, 17326, from Tower House, March 7. Seen also at Weaverville.

Zonotrichia coronata (Pallas). Golden-crowned Sparrow. Three skins, nos. 17327-17329, from Helena (February 14 and 23), and Tower House (March 8).

Spizella passerina arizonae Coues. Western Chipping Sparrow. Four specimens, nos. 19235-19238, from Scott River and South Fork of Salmon River, June 8 and 11, and July 13. Observed also at Kangaroo Creek, August 4.

Junco oreganus thurberi Anthony. Sierra Junco. Thirty-one specimens, nos. 17330-17338, 19239-19260, from the following localities: Helena, February 15 and 25; Tower House, March 1 and 2; Jackson Lake, June 17-26; north fork of Coffee Creek, July 2 and 6; South Fork of Salmon River, July 13 and 14; head of Grizzly Creek, July 21-31; Kangaroo Creek, August 4; head of Bear Creek, August 11 and 16; Castle Lake, August 19. This was the most wide-spread and abundant bird of the higher mountains during the summer.

Melospiza melodia rufina (Bonaparte). Rusty Song Sparrow. Eight skins, nos. 17343-17350, from Helena (February 15-24), and from Tower House (March 1-7). For use of this name see Kellogg (1911, p. 120).

Melospiza melodia fisherella Oberholser. Modoc Song Sparrow. Sixteen skins, nos. 17339-17342, 19261-19272, from Helena (February 16), Tower House (March 2-7), Scott River (June 8-12), Mayten (June 4 and 6), Castle Lake (August 20). Those from the first two localities were recorded (Kellogg, 1911, p. 120) under the name *merrilli*. This form of song sparrow was common on the more or less marshy ground around the Big Spring at Mayten; numerous also along the stream at the station on Scott River.

Melospiza lincolni lincolni (Audubon). Lincoln Sparrow. Eleven specimens, nos. 19273-19283, from Jacksou Lake (June 21), South Fork of Salmon River (July 14), head of Rush Creek (July 27), head of Bear Creek (August 6-10).

Passerella iliaca unalaschcensis (Gmelin). Shumagin Fox Sparrow. One specimen, no. 17351, from Helena, February 17.

Passerella iliaca meruloides (Vigors). Yakutat Fox Sparrow. One skin, no. 17352, from Tower House, March 8.

Passerella iliaca megarhyncha Baird. Thick-billed Fox Sparrow. Five skins, nos. 17353-17355, 19284, 19285, from Tower House (March 2 and 7), and Castle Lake (August 19 and 21). The

latter was the only locality where any form of fox sparrow was encountered during the summertime.

Pipilo maculatus falcinellus Swarth. Sacramento Towhee. Ten specimens, nos. 17356-17358, 19286-19292, from Tower House (March 1-5), Scott River (June 9-11), and Summerville (July 18). For systematic treatment, see Swarth (1913, pp. 168, 172). A nest with young just hatching was found at Scott River, June 10. It was on the ground under a branch of a fallen yellow pine and was screened by a bunch of dead pine needles.

Pipilo crissalis carolae McGregor. Northern Brown Towhee. Three skins, nos. 17359-17361, from Helena (February 24), and Tower House (March 1 and 7). For status of this form, see Grinnell (1912, p. 199).

Orcospiza chlorura (Audubon). Green-tailed Towhee. One specimen, no. 19293, from head of Bear Creek, August 6.

Zamelodia melanocephala capitalis (Baird). Pacific Black-headed Grosbeak. Three skins, nos. 19217-19219, from Scott River, June 9-11.

Passerina amoena (Say). Lazuli Bunting. Seven skins, nos. 19294-19300, Scott River and Summerville, June 9 to July 18. Particularly plentiful at the latter locality.

Piranga ludoviciana (Wilson). Western Tanager. Five skins, nos. 19301-19305, from Scott River, Jackson Lake, Summerville, and head of Rush Creek, taken in June and July. Seen at head of Bear Creek, August 11.

Bombycilla garrula (Linnaeus). Bohemian Waxwing. Nine specimens, nos. 17362-17370, from Helena and Tower House, February 9 to March 1. For further account, see Kellogg, 1911 (pp. 120-121).

Vireosylva gilva swainsoni (Baird). Western Warbling Vireo. Four skins, nos. 19306-19309, from Scott River and Jackson Lake (in June), and Kangaroo Creek (immature, August 4).

Lanivireo solitarius cassini (Xantus). Cassin Vireo. Six skins, nos. 19310-19315, from Scott River (June 10), head of Grizzly Creek (July 23), and head of Bear Creek (August 13).

Vireo huttoni huttoni Cassin. Hutton Vireo. One skin, no 17371, from Helena, February 20.

Vermivora ruficapilla gutturalis (Ridgway). Calaveras Warbler. Ten specimens, nos. 19316-19325, from Jackson Lake, South Fork of

Salmon River, head of Grizzly Creek, and head of Rush Creek (in June and July), and Castle Lake (August 20).

Vermivora celata lutescens (Ridgway). Lutescent Warbler. Four skins, nos. 19326-19329, from head of Grizzly Creek (July 23), head of Rush Creek (July 29), head of Bear Creek (August 11), and Castle Lake (August 21).

Dendroica aestiva brewsteri Grinnell. California Yellow Warbler. Seven skins, nos. 19330-19336, from Scott River, June 8-13.

Dendroica auduboni auduboni (Townsend). Audubon Warbler. Thirteen skins, nos. 19337-19349, from Jackson Lake (June 17-25), South Fork of Salmon River (July 14), head of Grizzly Creek (July 22 and 23), head of Bear Creek (August 12 and 15).

Dendroica nigrescens (Townsend). Black-throated Gray Warbler. Three skins, nos. 19350-19352, from Scott River (June 11), and Summerville (immatures, July 18 and 19).

Dendroica townsendi (Townsend). Townsend Warbler. One immature male, in full fall plumage, no. 19353, from head of Bear Creek, August 10. Probably a migrant.

Dendroica occidentalis (Townsend). Hermit Warbler. Three immatures, nos. 19354-19356, from head of Grizzly Creek (July 23), head of Rush Creek (July 28), head of Bear Creek (August 13).

Geothlypis trichas occidentalis Brewster. Western Yellowthroat. Four breeding adults, nos. 19357-19360, from Mayten and Scott River, June 4-11. Common on the more or less marshy ground around the "Big Spring" at Mayten. Nest with four eggs found there in bunch of dry tules, June 5. Nest with four eggs found near the ground in a cornus bush, June 11, at Scott River.

Icteria virens longicauda Lawrence. Long-tailed Chat. Four skins, nos. 19361-19364, from Scott River, June 12 and 13. Here the bushes along the creek seemed alive with different birds, largely because of the chat's voluble imitations of his various neighbors.

Wilsonia pusilla chryseola Ridgway. Golden Pileolated Warbler. Nine skins, nos. 19365-19373, from Jackson Lake (June 16-18), head of Grizzly Creek (July 21), and head of Bear Creek (August 6-16).

Cinclus mexicanus unicolor Bonaparte. American Dipper. One juvenile, no. 19374, North Fork of Coffee Creek, July 5.

Thryomanes bewicki drymoecus Oberholser. San Joaquin Wren. Three adult skins, no. 17372, from Helena, February 23, and nos. 19375, 19376, from Scott River, June 11.

Troglodytes aedon parkmani Audubon. Western House Wren. Ten specimens, nos. 19377-19386, from Scott River, head of Grizzly Creek, Summerville, head of Bear Creek, and Castle Lake, June to August.

Certhia familiaris zelotes Osgood. Sierra Creeper. Ten specimens, nos. 19387-19396, from North Fork of Coffee Creek, South Fork of Salmon River, head of Grizzly Creek, and head of Bear Creek, July and August.

Sitta carolinensis aculeata Cassin. Slender-billed Nuthatch. Two skins, nos. 19397, 19398, from Scott River, June 13.

Sitta canadensis Linnaeus. Red-breasted Nuthatch. Three skins, nos. 19399-19401, from head of Rush Creek (July 28), and head of Bear Creek (August 6 and 10).

Bacolophus inornatus inornatus (Gambel). Plain Titmouse. Three skins, nos. 17373, 17374, from Tower House, March 2, and no. 19402, from Scott River, June 9.

Penthestes atricapillus occidentalis (Baird). Oregon Chickadee. Four skins, nos. 19403-19406, from Scott River, six miles northwest of Callahan, June 10 and 13. Two are adults and two juvenals not fully grown, one of each on each of the two dates. This is the first unquestionably authentic record of this species for California.

Penthestes gambeli gambeli (Ridgway). Mountain Chickadee. Twenty-two skins, nos. 19407-19428, from Jackson Lake, south fork of Salmon River, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, and Castle Lake, June 16 to August 19.

Penthestes rufescens rufescens (Townsend). Chestnut-sided Chickadee. One skin, no. 17375, from Helena, February 15. Apparently numerous at this time and place, but not seen anywhere in the Trinity region during the summer.

Psaltriparus minimus minimus (Townsend). Coast Bush-tit. Five skins, nos. 17390-17392, 19429, 19430, from Tower House, March 7, and Scott River, June 8 and 11. For systematic status, see Swarth (1914, p. 510).

Chamaea fasciata henshawi Ridgway. Pallid Wren-tit. Fifteen specimens, nos. 17376-17389, from Helena and Tower House, Feb-

ruary 20 to March 7, and no. 19431, from Scott River, June 11. Most numerous at Tower House.

Regulus satrapa olivaceus Baird. Western Golden-crowned Kinglet. Seven skins, nos. 17432-17438, from South Fork of Salmon River (July 14 and 16), head of Grizzly Creek (July 21-23), and head of Rush Creek (July 27).

Regulus calendula (Linnaeus). Ruby-crowned Kinglet. Four skins, no. 17393, from Helena (February 14), no. 17394, from Tower House (March 7), no. 19439, from South Fork of Salmon River (July 16), and no. 19440, from head of Bear Creek (August 13).

Myadestes townsendi (Audubon). Townsend Solitaire. Five skins, nos. 17395, 17396, from Helena (February 14 and 23), no. 17397, from Tower House (March 1), no. 19441, from North Fork of Coffee Creek (July 3), and no. 19442, from Kangaroo Creek (August 4).

Hylocichla ustulata ustulata (Nuttall). Russet-backed Thrush. Two adult skins, nos. 19443, 19444, from Jackson Lake (June 25), and head of Grizzly Creek (July 23). Nest and four eggs (no. 1097) taken at Jackson Lake, June 25. This was situated three feet above the ground on a sagging branch of a small fir, and was loosely constructed of dry fir twigs, dead ferns and moss.

Hylocichla ustulata swainsoni (Tschudi). Olive-backed Thrush. One adult male, no. 19447, from head of Grizzly Creek, 6000 feet altitude, July 22.

Hylocichla guttata nanus (Audubon). Dwarf Hermit Thrush. Seven skins, nos. 17398-17404, from Helena and Tower House, February 13 to March 7.

Hylocichla guttata slevini Grinnell. Monterey Hermit Thrush. Two specimens: no. 19445, female juvenal, head of Rush Creek, July 29; no. 19446, female immature, head of Bear Creek, August 12.

Planesticus migratorius propinquus (Ridgway). Western Robin. Eight skins, nos. 17405, 17406, 19448-19453, from Helena (February 24), Mayten (June 5), Jackson Lake (June 19 and 24), and head of Bear Creek (August 10 and 16). At the latter locality and dates robins had gathered in flocks, feeding in the ceanothus brush.

Ixoreus naevius naevius (Gmelin). Varied Thrush. Three skins, nos. 17407-17409, from Helena and Tower House, February 13 to March 7.

Sialia mexicana occidentalis Townsend. Western Bluebird. Three specimens: nos. 17410, 17411, from Tower House, March 2; no. 19454, from Scott River, June 13. Common at Tower House in March, but notably scarce in summer throughout the Trinity region.

Sialia currucoides (Bechstein). Mountain Bluebird. One adult male, no. 19455, from Wildcat Peak, June 28.

Transmitted June 27, 1914.

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PLATE 15.

Fig. 1. View towards the east, of a portion of Scott River Valley, Siskiyou County, California, about six miles north of Callahan, altitude about 3,000 feet. Photograph taken June 13, 1911. The floor of the valley is timbered with yellow pine, cottonwood and willow. The hills shown in the picture were not visited, but looked much drier and were decidedly more sparsely timbered than the hills on the west side, at the base of which camp was located. These western hills were well covered with sage-brush, deer-brush and scattering groves of yellow pine. The sandy ground of an old creek bed proved to be good trapping ground for *Dipodomys californicus trinitatis*. Other small mammals of the lower lands were *Peromyscus maniculatus gambelii*, *Eutamias amoenus amoenus*, *Eutamias senex*, and *Citellus douglasii*. On the sidehill *Lepus californicus californicus* was common. *Dryobates pubescens gairdneri*, *Astragalinus tristis salicamans*, *Astragalinus psaltria hesperophilus*, *Chondestes grammacus strigatus*, *Melospiza melodia fisherella*, *Pipilo maculatus falcinellus*, *Zamelodia melanocephala capitalis*, *Dendroica aestiva brewsteri*, *Icteria virens longicauda* and *Penthestes atricapillus occidentalis* were birds which frequented the willow thickets along the small creek beds. On the sidehill were seen *Lophortyx californica vallicola*, *Melanerpes formicivorus bairdi* and *Piranga ludoviciana*. The life-zone may be considered mixed Upper Sonoran and Transition, prevalently the former.

Fig. 2. North side of Saloon Creek divide, Siskiyou County, California, altitude 6,275 feet. Photograph taken July 10, 1911. A scattering growth of silver pine and red fir on sidehill, and patches of alder along creek bottom. As a collecting station the locality was chosen chiefly because of the presence there of a colony of the golden-mantled ground squirrel (*Callospermophilus chrysodeirus trinitatis*). The small Klamath chipmunk (*Eutamias amoenus amoenus*) was almost as numerous and there was abundant sign of gophers (*Thomomys monticola pinetorum*). The life-zone here represented was the Canadian division of the Boreal.

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PLATE 16.

Fig. 3. Burrows of the Trinity mountain beaver (*Aplodontia chrysecola*) near Hunters' Camp, Grizzly Creek Cañon, Trinity County, California. Photograph taken July 19, 1911. The animals had taken advantage of the protection afforded by the tangled roots of a fallen tree. Although the ground was here dry, there was running water within a few yards to one side.

Fig. 4. Mouth of burrow of *Aplodontia chrysecola*, showing heap of freshly-cut vegetation. Photograph taken near Hunters' Camp, Grizzly Creek Cañon, Trinity County, California, July 19, 1911. The presence in this locality, as well as at several other points, of cuttings of grass and leaves seems to establish the fact that these mammals gather and dry vegetable materials for subsequent use.

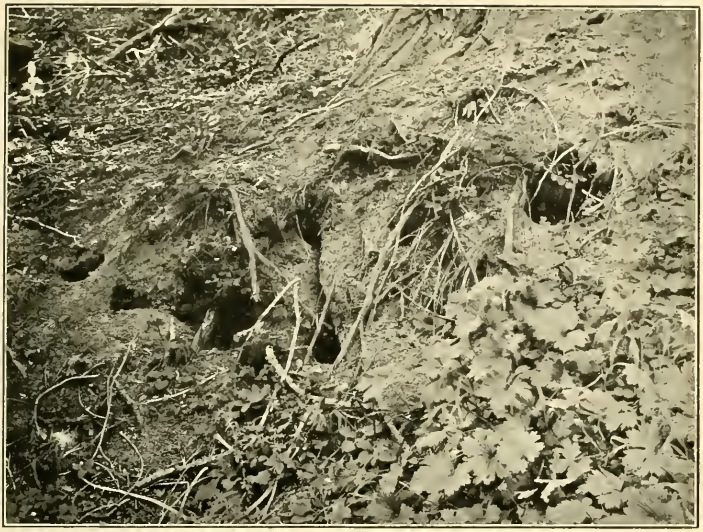

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PLATE 17.

Fig. 5. View taken July 23, 1911, looking towards head of Grizzly Creek, Trinity County, California, altitude about 6,000 feet. The timber is white pine, red fir, and hemlock, scattered through a meadow and reaching up on the rocky slopes of Thompson Peak, the summit in the background. A bank of perpetual snow feeds a lake from which a waterfall (shown in left center) descends to form Grizzly Creek. Small mammals were not numerous but included *Microtus mordax mordax*, *Zapus trinotatus alleni*, and the two species of *Eutamias*, *amoenus* and *senex*. *Aplodontia chryscola* was fairly abundant on the west side of the cañon, and a number of black-tailed deer were seen in the neighborhood. Birds noted were: *Nuttallornis borealis*, *Cyanocitta stelleri frontalis*, *Junco oreganus thurberi*, *Lanivireo solitarius cassini*, *Vermivora rubricapilla gutturalis*, *Vermivora celata lutescens*, *Dendroica auduboni auduboni*, *Dendroica occidentalis*, *Certhia familiaris zelotes*, *Penthestes gambeli gambeli*, *Regulus satrapa olivaceus*, *Hylocichla ustulata ustulata*, *Hylocichla ustulata swainsoni* (one specimen). The life-zone represented is evidently Boreal, in its Canadian and Hudsonian divisions.

Fig. 6. View taken July 31, 1911, looking southwest from head of Rush Creek, Siskiyou County, California, towards the Salmon Mountains; altitude about 6,400 feet. A typical Boreal meadow of luxuriant grasses, with thickets of alder and patches of hellebore. Red firs skirt the edge of the meadow and, interspersed with hemlock, extend in dense stand to the top of the divide. Below the meadow the silver pine and cedar predominate. Small mammals taken in and near the meadow were: *Sorex vagrans amoenus*, *Peromyscus maniculatus gambelii*, *Microtus mordax mordax*, *Thomomys monticola pinetorum* and *Zapus trinotatus alleni*. *Glaucomys sabrinus flaviventris* was abundant in the groves of red fir, and in a side cañon three marten (*Martes caurina caurina*) were secured. Birds were confined chiefly to the meadow and its vicinity, and included *Oreortyx picta picta*, *Dendragapus obscurus sierrae*, *Cyanocitta stelleri frontalis*, *Junco oreganus thurberi*, *Melospiza lincolni lincolni*, *Dendroica occidentalis*, *Penthestes gambeli gambeli* and *Hylocichla guttata stevini*.

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PLATE 18.

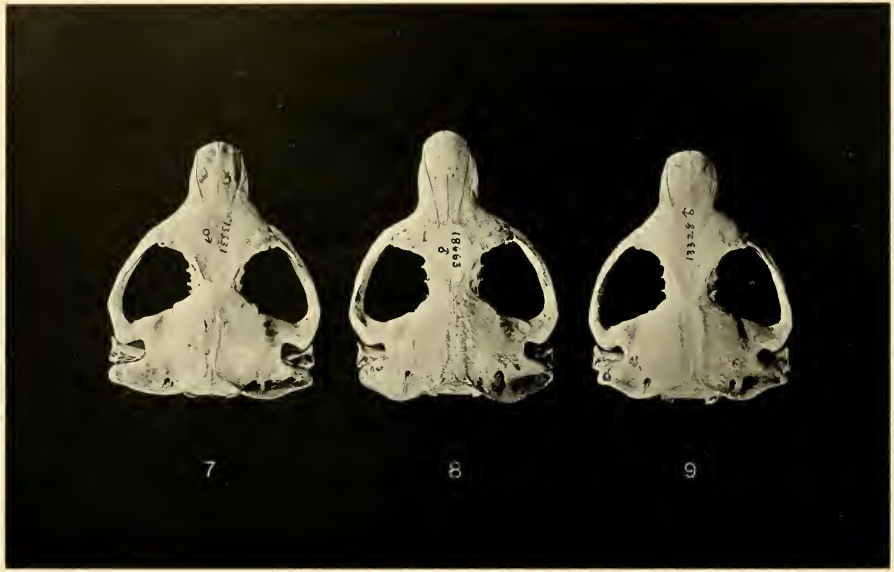
Skulls of *Aplodontia;* all × 0.62.

Fig. 7. *A. chryseola* Kellogg: ♂, no. 13331, Mus. Vert. Zool., head of Grizzly Creek, Trinity County, California.

Fig. 8. *A. californica* (Peters): ♂, no. 18663, Mus. Vert. Zool., Blue Cañon, Placer County, California.

Fig. 9. *A. chryseola* Kellogg: ♂, type, no. 13328, Mus. Vert. Zool., Jackson Lake, Siskiyou County, California.

Note in *A. chryseola* (the two end skulls): the short rostrum, short and broad nasals, expanded frontal region, broad rostrum posteriorly, less squarish zygomatic arch, broad interorbital constriction, and lengthened auditory tubes.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AN ANALYSIS OF THE VERTEBRATE FAUNA OF THE TRINITY REGION OF NORTHERN CALIFORNIA

BY

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(Contribution from the Museum of Vertebrate Zoology of the University of California)

From the array of facts presented in the foregoing paper (Kellogg, 1916), in conjunction with what is known of adjacent areas, it seems possible to draw some general inferences as to the composition and derivation of the vertebrate fauna of the Trinity region. Faunas vary through a wide range in degree of distinctness, from that which is scarcely different from the one or ones adjacent, to the fauna which is of marked peculiarity, showing throughout nearly all its elements totally distinct characters. An example of the latter would be the San Diegan fauna as compared with the adjacent Colorado Desert fauna (see Grinnell and Swarth, 1913, page 388). Of far less degree of difference, we may cite the Santa Cruz faunal division of the Humid Coast Belt as compared with the Marin division of the same belt.

The difficulties arising in attempts to diagnose and properly classify faunas are surprisingly similar to those encountered in dealing with subspecies, species, genera and other systematic groups. Not only is there such wide variability in amounts of difference between faunas as to make the matter of rank often indeterminable, but exact geographic boundaries may be impossible to fix because of intergradation over intermediate territory of greater or less width. As in some cases of intergrading series of subspecies, the location of lines of separation may be subject only to arbitrary choice, so that where six faunas might be recognized by one student, only three would be thought properly distinguishable by another.

The fauna of the Trinity region seems to be best dealt with, by considering its Boreal zonal elements, and its Sonoran (or Austral) zonal elements, separately. Adjacent Boreal faunas are those of: (1) the Sierra Nevada of east central California, (2) the Cascades of Oregon, (3) the Humboldt Bay division of the Humid Coast Belt. Adjacent Sonoran faunas are those of: (1) the Sacramento Valley, (2) the Modoc region of northeastern California, (3) the Humid Coast Belt. The following tabulations will serve to segregate the pertinent facts appropriately:

Table 1. Boreal species of the Trinity region which occur also on both the Sierra Nevada and the Cascade Mountains, but not as regular members of the humid coast fauna.

MAMMALS

Canis lestes (there are indications that a separate form exists in the area towards the coast from Mount Shasta, of which the Trinity region is a part).
Martes caurina caurina (subspecific status in doubt; probably differing from the Cascade animal and most nearly identical with a Sierran race).
Martes pennanti pacifica (subject to same remark as above).
Microtus mordax mordax.
Eutamias amoenus amoenus.
Eutamias senex.
Callospermophilus chrysodeirus trinitatis (very slightly different from *C. c. chrysodeirus* of the Sierras and Cascades).

BIRDS

Dryobates villosus orius (intergradient towards the humid coast form *harrisi*).
Xenopicus albolarvatus albolarvatus.
Asyndesmus lewisi (possibly not to be considered Boreal).
Stellula calliope.
Empidonax wrighti (possibly a straggler, merely).
Nucifraga columbiana.
Carpodacus cassini.
Melospiza lincolni lincolni.
Oreospiza chlorura.
Vermivora ruficapilla gutturalis.
Dendroica auduboni auduboni.
Dendroica nigrescens (not strictly Boreal).
Dendroica occidentalis.
Certhia familiaris zelotes.
Penthestes gambeli gambeli.
Myadestes townsendi.
Sialia currucoides.

Table 2. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives on the Sierra Nevada, but not on the Cascades.

MAMMALS

Sorex vagrans amoenus (very slightly differentiated from *S. v. vagrans*, of the humid coast belt and the Cascades).
Mustela muricus.
Microtus montanus montanus (found only at Mayten; occurs also in the Klamath region at extreme southern end of Cascades).
Thomomys monticola pinetorum (very slightly different from *T. m. monticola* of the Sierra Nevada).
Zapus trinotatus alleni.
Aplodontia chryscola (decidedly different from *A. californica* of the Sierra Nevada).
Sciurus douglasii albolimbatus.
Glaucomys sabrinus flaviventris.

BIRDS

Dendragapus obscurus sierrae (intergradient towards the humid coast form *fuliginosus*).
Sphyrapicus varius daggetti.
Cyanocitta stelleri frontalis (slightly intergradient towards the coast form *carbonacea*).
Junco oreganus thurberi.
Passerella iliaca megarhyncha.

Table 3. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives on the Cascade Mountains, but not on the main Sierra Nevada.

MAMMALS

Mustela saturata.
Neotoma cinerea occidentalis (occurs also on northern Sierra Nevada and locally to the coast).
Evotomys obscurus (also on extreme northern Sierra Nevada).
Lepus washingtonii klamathensis (the snowshoe rabbit reported under this name from the central Sierra Nevada, is probably distinct from *klamathensis*).

BIRDS

(none)

Table 4. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives in the humid coast belt.

MAMMALS

Scapanus latimanus latimanus (wide ranging zonally to the southward through the coast ranges; not a typical humid coast form; group relationships not yet worked out satisfactorily).

Neurotrichus gibbsi major (status of races not worked out satisfactorily; while the genus belongs to the northwest coast belt, there may prove to be a Sierran subspecies with which the Trinity animal belongs).
Sorex montereyensis montereyensis (but slightly different from the Sierran form, *S. m. mariposae*).
Lynx fasciatus.
Odocoileus columbianus columbianus.

BIRDS

Oreortyx picta picta.
Dendragapus obscurus fuliginosus (intergradient towards the Sierran form *sierrae*).
Melospiza melodia rufina (in winter, only).
Penthestes atricapillus occidentalis.
Penthestes rufescens rufescens (in winter, only?).
Hylocichla guttata slevini.

Table 5. Boreal species of the Trinity region which appear to be endemic, that is, different from related forms in either the Sierra Nevada, the Cascades, or the humid coast belt.

MAMMALS

Thomomys monticola pinetorum (extends also to Mount Shasta).
Aplodontia chryscola.
Callospermophilus chrysodeirus trinitatis.
Glaucomys sabrinus flaviventris.

BIRDS

(none)

Table 6. Sonoran species of the Trinity region which belong to variable groups and which are identical with, or show nearest affinities to, representatives in the Sacramento Valley.

MAMMALS

Bassariscus astutus raptor (extends also through the coast ranges to the southward and into Oregon on the north).
Spilogale phenax phenax (wide-ranging through the coastal region to the south).
Mephitis occidentalis occidentalis (wide-ranging through many faunas to the south).
Peromyscus boylii boylii.
Peromyscus truei gilberti.
Microtus californicus californicus.
Thomomys leucodon navus.
Dipodomys californicus trinitatis (slightly different from the form *D. c. californicus* of the upper Sacramento Valley).
Lepus californicus californicus (also ranges locally nearly or quite through the coast belt).

BIRDS

Lophortyx californica californica.
Astragalinus tristis salicamans (also in humid coast belt).
Astragalinus psaltria hesperophilus.
Chondestes grammacus strigatus (occurs also in the Great Basin).
Pipilo maculatus falcinellus.
Pipilo crissalis carolae.
Thryomanes bewicki drymoecus.
Bacolophus inornatus inornatus.
Chamaea fasciata henshawi.

Table 7. Sonoran species of the Trinity region which belong to variable groups, and which are identical with, or show nearest affinities to, representatives in the Modoc region.

MAMMALS

Reithrodontomys megalotis klamathensis.

BIRDS

Agelaius phoeniceus nevadensis (found at Mayten only, in Shasta Valley; so not really a bird of the Trinity region as explicitly defined).
Melospiza melodia fisherella.

Table 8. Sonoran species of the Trinity region which belong to variable groups and which are identical with, or show nearest affinities to, representatives in the humid coast belt.

MAMMALS

Neotoma fuscipes fuscipes (not exclusively a humid coast form; ranges across head of Sacramento Valley).
Sylvilagus bachmani ubericolor (extends also interiorly across head of Sacramento Valley).

BIRDS

Dryobates pubescens gairdneri (tending towards the race *turati*, of the Sacramento Valley and other faunas to the southward).
Psaltriparus minimus minimus (ranges somewhat beyond the most restricted confines of the humid coast belt).

Table 9. Sonoran species of the Trinity region which are apparently endemic, that is, different from related forms in any of the other faunas.

MAMMALS

Dipodomys californicus trinitatis.

BIRDS
(none)

Table 10. Species which are either so widespread through all the faunas here concerned as to be non-significant in the present study, or which are of unknown status.

MAMMALS

Myotis longicrus longicrus.
Lasionycteris noctivagans.
Eptesicus fuscus fuscus.
Ursus amcricanus.
Urocyon cinercoargenteus townsendi (merging into the races *U. c. californicus* and *U. c. sequotensis* immediately to the south of the Trinity region).
Procyon psora pacifica.
Mustela vison energumenos.
Felis oregonensis oregonensis.
Peromyscus maniculatus gambelii (slightly intermediate towards the humid coast form *rubidus*).
Citellus douglasii.
Sciurus griseus griseus (apparently non-differentiated in the three Boreal faunas here concerned!).

BIRDS

Actitis macularius.
Oxyechus vociferus.
Zenaidura macroura marginella.
Accipiter velox.
Accipiter cooperi.
Astur atricapillus striatulus.
Falco sparverius sparverius.
Phloeotomus pileatus abieticola.
Melanerpes formicivorus bairdi.
Colaptes cafer collaris (not approaching the northern humid coast form *saturatior*).
Selasphorus rufus (probably a migrant, only).
Sayornis nigricans (in winter, only, and not in the main Trinity region.
Nuttallornis borealis.
Myiochanes richardsoni richardsoni.
Empidonax trailli trailli.
Empidonax hammondi (not certainly breeding).
Aphelocoma californica californica.
Sturnella neglecta.
Icterus bullocki.
Euphagus cyanocephalus.
Hesperiphona vespertina montana (probably only in winter).
Carpodacus purpureus californicus.
Carpodacus mexicanus frontalis.
Spinus pinus pinus.
Passer domesticus.
Zonotrichia coronata (in winter, only).
Spizella passerina arizonae.
Passerella iliaca anialaschcensis (in winter, only).
Passerella iliaca meruloides (in winter, only).
Zamelodia melanocephala capitalis.
Passerina amoena.

Piranga ludoviciana.
Bombycilla garrula (in winter, only).
Vireosylva gilva swainsoni.
Lanivireo solitarius cassini.
Vireo huttoni huttoni.
Vermivora celata lutescens.
Dendroica aestiva brewsteri.
Dendroica townsendi (probably a transient, only).
Geothlypis trichas occidentalis.
Icteria virens longicauda.
Wilsonia pusilla chryseola.
Cinclus mexicanus unicolor.
Troglodytes aedon parkmani.
Sitta carolinensis aculeata.
Sitta canadensis.
Regulus satrapa olivaceus.
Regulus calendula.
Hylocichla ustulata ustulata.
Hylocichla ustulata swainsoni (possibly an exceptional occurrence).
Hylocichla guttata nanus (in winter, only).
Planesticus migratorius propinquus.
Ixoreus naevius naevius (in winter, only).
Sialia mexicana occidentalis.

Kellogg (1916) lists 47 mammals and 95 birds from the Trinity region, a total of 142 vertebrate species. In spite of the very high grade of field-work carried on by Misses Alexander and Kellogg during the time of their exploration in the region, it is not for a moment to be inferred that this is the total number of mammal and bird species regularly occurring in the region. But it is the *known* fauna. A few included species may prove to be stragglers and not really to be considered in faunal analysis. Obviously the present assignment of species must be accepted only as provisional; at the same time it is probable that the general situation as regards proportional constituency of the various categories of species would remain very nearly the same as here indicated, even after such intensive and long-continued survey as might be devoted to the Trinity region in the future. Increments from future field-work would be likely to be distributed pretty evenly among the several categories so that the ratios would continue but little if any changed.

As indicated in the foregoing tables, 65 species out of the total 142 are either widespread through all the faunas here concerned or are of unknown status, in either case being removed from consideration in any attempt to establish *differences* between the faunas. This disposes at once of 46 percent of the Trinity fauna.

As is well known, the appertaining faunas of greatest contrast are those of the humid coast belt and the Sierra-Cascades. Twenty-four Boreal species, or 17 percent of the Trinity mammals and birds, occur also on both the Sierra Nevada and the Cascade Mountains, but not regularly as elements of the humid coast fauna. Also there are thirteen species, or 9 percent, of the Trinity boreal fauna which are identical with, or show closest affinities to, representatives on the Sierra Nevada, but not on the Cascades; and there are four species, or 3 percent, of the Trinity Boreal fauna which are identical with, or show closest affinities to, representatives on the Cascade Mountains, but not on the main Sierra Nevada. Mount Shasta is here considered as properly included in the Sierran fauna. This mountain, in spite of its relative isolation, certainly shows only minor differences from the main central Sierras (see Merriam, 1899, pp. 71-81).

It is thus to be seen that a total of 41 mammals and birds, or 28 percent of its species, are shared by the Trinity fauna exclusively with that of both the Sierras and Cascades together. On the other hand, there are only eleven, or less than 8 percent, of the Trinity species which are shared exclusively with the closely adjacent humid coast fauna. As regards its Boreal elements, therefore, we may conclude that the Trinity fauna is much more nearly allied to the Sierra-Cascades than to the humid coast belt.

The fauna of the Trinity region is preponderantly Boreal; much the larger part of the territory lies in the Transition and Canadian life-zones. The strictly Sonoran (Upper Sonoran) elements occur only in the valleys of low altitude. Of these there are three, of small area, situated in the interior of the region: Scott River, south fork of the Salmon River at Summerville, and Trinity River in the vicinity of Helena; and two on the borders: Shasta Valley, in which Mayten is situated, and the upper extremity of the Sacramento Valley in the vicinity of Tower House. Taking into account chiefly the Sonoran "islands", we find that the Trinity region possesses 18 species in common with the Sacramento Valley. This is somewhat less than 12 percent of the total mammal and bird fauna of the Trinity area. Three species, or little more than 2 percent, are shared with the Modoc region of extreme northeastern California (and which has its western confines in Shasta Valley); while only four Sonoran species, not quite 3 percent, occur also in the humid coast belt.

It would thus appear that, as regards its Sonoran fauna, the Trinity region allies itself strongly with the Sacramento fauna rather than with either of the other two named.

As far as specimens have become available and carefully studied (Kellogg, 1916), only five endemic forms have been found, all mammals. Four of these are Boreal: *Thomomys monticola pinetorum* Merriam, *Aplodontia chryscola* Kellogg, *Callospermophilus chrysodeirus trinitatis* Merriam, and *Glaucomys sabrinus flaviventris* Howell; one is Sonoran: *Dipodomys californicus trinitatis* Kellogg. Only one of the five is well-marked, the *Aplodontia*, the other four being but faintly characterized. This indicates a differentiation center of weak power.

It is apparent that the Trinity region shows but weak faunal individuality. It is not sharply set off, except on the west, nor does it contain notably distinct forms. This relative unimportance as a differentiation center is doubtless due to its small area and to the lack of efficient barriers which would prevent intercrossing with representatives in adjacent faunas. No very low zone is interposed, the Transition, merely, being continuous between the Boreal areas. The climatic features, too, are clearly not so pronouncedly different from those of the Sierra Nevada as to make up for the very short distance between the main Trinity mass and the Sierras.

There must be a very abrupt line of demarcation between the Trinity fauna and the humid coast fauna, for we have very few forms venturing from the latter into the former, in spite of the very short distance. It is true that with a few birds we find intergrades in the Trinity region between typical Sierran and typical coast-belt forms; for example, in the genera *Dendragapus*, *Dryobates* and *Cyanocitta*. But in by far the greater number of appropriate cases, in both birds and mammals, the Trinity representatives are unequivocally of interior forms, and this in spite of the fact that practically all of the Trinity drainage is west directly to the Pacific and lies within a maximum distance of ninety miles of the coast. The climatic barrier, of abruptly and greatly increased humidity on the west, is evidently much more efficient in checking the spread of species than the various Transition-zone "gaps" between the mountain masses of the interior or the Transition-zone divides between the "islands" of Upper Sonoran.

The whole idea of basing the efficacy of zonal "gaps" on the summation of the species occurring on either side (see Merriam,

1899, pp. 69-86) must to the writer's mind be reconsidered. Zone must be thought of in conjunction with conditions of varying humidity, associational features, and relative sizes of all the segregated areas concerned. Species may be delimited in their ranges by other factors than that of temperature. This remark is not, however, meant as implying a denial that temperature is the one factor most frequently limiting the ranges of species. A narrow Transition-zone gap between two Boreal areas, as that at Sisson, between mounts Eddy and Shasta, cannot serve as a particularly effective barrier between the Boreal species encountering it, unless it be coupled with, on opposite sides, marked differences in humidity or associational conditions, which, however, do not appear to exist in the present instance.

The problem here arises, how to treat the Trinity region in faunal nomenclature. What is the criterion for nominal separation of faunas? What percentage of its species have to be peculiar, or what minimum ratio of differences obtain in comparison with the animal life of adjacent areas, to render the Trinity assemblage of forms worthy of separate recognition by name on our faunal maps? Mount Shasta has but two mammals and two birds (even these doubtful), which do not occur on the central Sierras; it is chiefly characterized by absence of forms (due to its small area). We are therefore led to include Mount Shasta with the Sierra Nevada in the "Sierra Nevadan Faunal Area". But we do not hesitate to recognize as distinct the Cascade fauna and the Sierra Nevadan fauna. And the Humid Coast fauna is conspicuously peculiar.

The difficulties here encountered have been alluded to in a preceding paragraph. The Trinity region in its vertebrate animal life resembles much more closely the Sierras than the Cascades; it is in a way intermediate, but has in addition some humid coast elements. The differences between the Trinity and Sierran faunas are concerned with only eleven percent of its species all told. Is this a sufficient *amount* of difference to warrant their recognition as distinct faunal areas, as indicated on a current distributional map (Grinnell, 1913, pl. 16)? Possibly not, though the writer believes that for purposes of faunal analysis such fine distinctions may be useful. It will depend on circumstances, for, with wider problems in view, it might for the moment be better to lump the Trinity area in with the Sierra Nevada under a common designation. Expediency will fix the criterion for recognizing faunal division, and this may

vary as circumstances vary, just as with the recognition of genera, families, etc. The term subfauna has been previously employed for the more slightly characterized assemblages of animal inhabitants, and this might be a useful term to adopt regularly in connection with such minor faunal divisions as that of the Trinity region.

The exact location of boundaries for the Trinity subfauna is a matter of uncertainty. This uncertainty arises from two circumstances: first, that, as experience elsewhere would lead one to expect, there are broad marginal belts of intermingling, rather than sharp lines of demarcation; and, second, lack as yet of exploration of much of the surrounding territory. No field-work has been done by anyone connected with the California Museum of Vertebrate Zoology on a line directly to the coast west from the Salmon Mountains. To the north, the Siskiyou Mountains, across the deep Klamath River cañon, are so far known only as regards their birds (see Anderson and Grinnell, 1903). The birds are indicative of close faunal similarity of the Siskiyou and Trinity mountain masses. To the south, the Yolla Bolly country presents some obvious peculiarities of its own, but here, again, no adequate study has been accorded the animal life, and conclusions are therefore best deferred. To the east, the Trinity area seems satisfactorily bounded by the upper Sacramento Valley and by Shasta Valley together with the interconnectant Sisson gap, extending between mounts Shasta and Eddy.

Summary.—The collections of specimens thus far available from the Trinity region cannot be considered anywhere nearly complete; neither is there sufficient information at hand, published or otherwise, concerning the Cascades. Even with the best-worked of the faunas here concerned, that of the Sierra Nevada particularly in its Mount Shasta portion, much remains in doubt. The statistics here set forth must therefore be considered provisional. Nevertheless the general conclusions are believed closely to approximate the truth.

The Trinity region as regards its Boreal fauna is clearly far more closely allied to the Sierra-Cascade fauna than to the Humid Coast fauna. It is nearer to the Sierran fauna than to the Cascade fauna; indeed it might with propriety be included in the Sierra Nevadan faunal area, ranking merely as a subfauna.

The Trinity region contains some Sonoran "islands". The fauna of these is most closely similar to that of the Sacramento Valley; there are a few Great Basin or Modoc forms, and but scanty evidence of humid coast intrusion.

The Trinity region shows but very slight endemic individuality. It possesses but five distinguishable races or species of its own, four of which are Boreal and one Sonoran. Only one of these is well marked.

The failure of the Trinity Mountains to have developed a markedly distinct fauna from that of the Sierra Nevada, may be ascribed to three conditions: (1) Absence of extreme, that is, practically insurmountable, barriers, such as a continuous body of water, or a strip of the Sonoran zone, or a belt of excessive aridity; (2) close similarity in those features of climate included in the term humidity, for zonal identity implies similar temperature conditions at least as to mean; (3) small area as compared with that of adjacent mountain masses which, because of the greater mass of their fauna, have exerted a dominating influence in the interacting processes of invasion.

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THE STATUS OF THE BEAVERS OF WESTERN NORTH AMERICA, WITH A CONSIDERATION OF THE FACTORS IN THEIR SPECIATION

BY

WALTER P. TAYLOR

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THE STATUS OF THE BEAVERS OF WESTERN NORTH AMERICA, WITH A CONSIDERATION OF THE FACTORS IN THEIR SPECIATION

BY
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(Contribution from the Museum of Vertebrate Zoology of the University of California)

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INTRODUCTION

EVOLUTIONARY CONSIDERATIONS

Problems concerning the causes and conditions of organic evolution are numerous and many of them are as yet unsolved. Even a cursory examination of zoological literature for a number of years reveals the fact that one branch of investigation has held the center of the stage for a time, only to be displaced by another and this in turn by another. This tendency toward successive popularity of different fields of work is for the most part good, of course, since it

leads to the discovery of new problems, the evolution of new theories, and the coordinated accumulation of new facts. Ill effects, however, may sometimes be realized as a result of it. A field of investigation the resources of which are by no means exhausted may be forsaken by those best fitted to prosecute researches therein on the ground that some other field looks more promising.

The studies of chorology, that is to say, of the geographical distribution of living forms, and of the relations of the living organism to its natural environment, hold, in the opinion of the writer, positions in scientific interest subordinate to those to which their abundant and practically unexplored resources would seem appropriately to assign them.

With the swing of the pendulum of scientific interest away from these fields, work on what is probably an important condition in polytypic evolution, namely, *isolation*, has practically ceased. The large place in organic evolution which may be filled by this condition has been emphasized by Wagner (1868), Dixon (1885), Romanes (1886), Gulick (1905), and Jordan (1905).

Questions arise immediately: What is isolation? Has it any importance in organic evolution? Is it not all-important? Have not the mutation and Mendelian concepts of the last few years done away with the necessity for postulating it at all as a condition of evolution? If isolation is the fictitious result of speculative induction, the sooner the concept is thrown overboard the better. If, on the other hand, it is of importance as a factor in the evolution of any group of living forms, it ought to receive broader recognition than it has heretofore.

It is the intention to present here some of the facts which seem to demand consideration, and which are drawn, not only from the study of beavers, but also from the geographical distribution and relationships of certain other families of west American (chiefly Californian) mammals. It is the hope of the writer that he may be able to emphasize: The importance of the study of isolation and certain related problems; the pertinence and indispensability of evidence from zoogeography.

DETAILS OF TREATMENT

In the preparation of this paper the inadequacy of material has been sharply felt. Still, it has been possible to get together a greater

amount of critical material representative of western beavers than has probably ever before been available to any one worker.

Ridgway's *Color Standards and Color Nomenclature* (1912) has been used as a guide to color names.

Overhair, as used in the following pages, refers to the long hairs making up the contour pelage, those which would be removed in the furrier's process of plucking. The *underfur* is the short, soft hair which covers the skin closely and which remains in the plucked skin.

For manner of taking cranial measurements see Taylor, 1911, p. 206. Special or exceptional methods of measuring are explained in the course of the paper.

Material and Acknowledgments

For the loan of material grateful acknowledgment is made to the following institutions: The United States National Museum through Mr. Richard Rathbun, Assistant Secretary, and Mr. Gerrit S. Miller, Jr., Curator, Division of Mammals; the Field Museum of Natural History through Mr. Wilfred H. Osgood, Assistant Curator of Mammalogy and Ornithology; and the United States Department of Agriculture through Mr. H. W. Henshaw, Chief of the Bureau of Biological Survey.

Considerable material representative of western beavers is contained in the collection of the Museum of Vertebrate Zoology of the University of California. The gathering of this material has been largely due to the interest of Miss Annie M. Alexander in the particular problem. The specimens from the San Joaquin River, California, were obtained directly by her from a local trapper, and those from Vancouver Island and southeastern Alaska were collected on three expeditions from the Museum made possible through means furnished by her. Altogether 86 specimens of beavers, some represented by skins and skulls, others by skulls alone or skins alone, and one by jaws only, have been available for study.

The writer is also indebted to the following persons, who have very generously given of their time and interest in assisting through helpful criticism and suggestion: Professor Charles A. Kofoid, Professor Samuel J. Holmes, Professor J. Frank Daniel, Professor John C. Merriam, Dr. Harold C. Bryant, Mr. F. H. Holden, and especially Dr. Joseph Grinnell.

Nomenclature

Three species of beavers, with altogether twelve subspecies, have been described from North America.

The American beaver was separated from the European by Kuhl (1820, p. 64) under the name of *Castor canadensis*, its type locality being Hudson Bay.

The specific name *americanus* was applied to the American beaver by F. Cuvier (1821, not seen) but this name is antedated by Kuhl's *canadensis*. Although the account on which Kuhl's name is based is fragmentary, it includes a description of the animal.

Gray (1869, p. 293) separated the beaver of the "northwest coast of America" as *Castor canadensis leucodonta*. This description was on the basis of specimens collected by Dr. Robert Brown. It is very probable that they were obtained on Vancouver Island (Osgood, 1907, p. 47).

The beaver of northern Mexico and the southern Rocky Mountain region was described by Mearns (1897, p. 502) under the name *Castor canadensis frondator*, its type locality being San Pedro River, Sonora, Mexico, near monument no. 98 of the Mexican boundary line.

A year later two more races were described by Rhoads (1898, pp. 420 and 422 respectively): *Castor canadensis carolinensis*, type locality Dan River, near Danbury, Stokes County, North Carolina; and *Castor canadensis pacificus*, type locality Lake Kichelos or Kecheelus, Cascade Mountains, Kittitas County, Washington.

The beaver of Texas was shown to be distinct by Bailey (1905, p. 122), and was described as *Castor canadensis texensis*, type locality Cummings Creek, Colorado County, Texas.

Expeditions from the Museum of Vertebrate Zoology of the University of California found beavers on several of the islands of southeastern Alaska, although Admiralty Island is the only one which is so far represented by specimens. The race found on this island was described by Heller (1909, p. 250) as *Castor canadensis phaeus*, type locality Pleasant Bay, Admiralty Island, Alaska.

The beaver inhabiting the Sacramento and San Joaquin valleys of California was recently characterized as a full species, *Castor subauratus* (Taylor, 1912, p. 167), type locality Grayson, Stanislaus County, San Joaquin River, California.

The beaver of Newfoundland, like so many others of the mammals inhabiting that island, is apparently restricted to it alone. It was

recently described by Bangs (1913, p. 513), under the name of *Castor caecator*.

Two more subspecies of *canadensis*, presenting respectively a very pale desert coloration, and a dark, rich coloration, have been described by Bailey (1913, pp. 191-193). These are *Castor canadensis mexicanus*, type locality Ruidoso Creek, six miles below Ruidoso, New Mexico, and *Castor canadensis michiganensis*, type locality Tahquamenaw River (five miles above falls), Luce County, Michigan.

The beavers of the west coast recognized in this paper are as follows:

Castor canadensis belugae, new subspecies (see p. 429), Cook Inlet region, base of Alaska Peninsula and probably Kenai Peninsula, and southward west of Rocky Mountains to central British Columbia.

Castor canadensis phaeus Heller, Admiralty Island, Alaska; probably neighboring islands and mainland.

Castor canadensis leucodonta Gray, Vancouver Island.

Castor canadensis pacificus Rhoads, probably mainland of British Columbia, Washington and Oregon; precise limits of range unknown.

Castor canadensis frondator Mearns, Colorado River drainage, and probably of broad distribution in southern Great Basin region.

Castor subauratus subauratus Taylor, Sacramento, Feather, American, and San Joaquin rivers, California.

Castor subauratus shastensis, new subspecies (see p. 433), east of Sierra Nevada Mountains, California; drainage of the Pit River.

Change Due to Age in a Single Species (*Castor canadensis leucodonta* Gray)

Beavers secured on Vancouver Island by the expedition of the Museum of Vertebrate Zoology in 1910 represent three generations, and so make possible an outline of the changes in certain characteristics due to age.

EXTERNAL CHARACTERS

Measurements

(See table, p. 419)

Difficulties are immediately apparent when one attempts to set down laws of change of form with age, the most important of which are that *(a)* weights and measurements of the youngest beavers are

I. EXTERNAL MEASUREMENTS* OF *Castor canadensis leucodonta* FROM VANCOUVER ISLAND, BRITISH COLUMBIA

Specimens arranged approximately in order of age from top of table to bottom
(All measurements in millimeters)

Museum number	Sex	LOCALITY	Total length	Tail vertebrae	Hind foot	Ear†	Weight in pounds	Length scaled portion of tail (dry skin)	Width scaled portion of tail (dry skin)	Number of scale-rows in broadest part of tail	Ratio tail vertebrae to total length	Ratio width scaled portion of tail to length
12109	?	Hall's Ranch, Alberni Valley	.....	.....	.....	....	....	94.6	37.6	31	....	39.7
12110	?	Hall's Ranch, Alberni Valley	.....	.....	.....	....	....	110.6	43.1	....	....	39.1
12106	♂	Hall's Ranch, Alberni Valley	.....	.....	.....	....	....	116.0	42.3	31	....	36.7
12105	♀	Hall's Ranch, Alberni Valley	503	162	93	24	....	124.2	39.5	34	32.2	31.8
12104	♀	Hall's Ranch, Alberni Valley	900	280	165	22	22	213	92	31	31.1	43.2
12108	♀	Hall's Ranch, Alberni Valley	967	400	170	38	25	260	98	35	41.4	37.7
12102	♂	Hall's Ranch, Alberni Valley	932	350	173	31	28	225	99	35	37.5	43.0
12103	♀	Hall's Ranch, Alberni Valley	925	350	170	25	28	225	94	34	37.8	41.8
12101	♂	Hall's Ranch, Alberni Valley	1000	340	175	31	38	237	120.9	34	34.0	51.0
12111	♂	Great Central Lake.....	990	395	175	30	42	243	108.5	34	39.9	44.6
12107	♀	Hall's Ranch, Alberni Valley	1157	450	200	33	49.5	270	124.2	33	38.9	46.9

*For method of taking measurements see Taylor, 1911, pp. 206, 207.
†Ear from crown.

lacking; *(b)* dimensions of the scaled portions of the tails were not usually taken in the field, and absolutely accurate measurement is impossible in dry skins on account of their shrinking and crinkling; *(c)* the irregularity of their arrangement makes it difficult to avoid error in counting the scale-rows transversely on the tail.

Keeping these possibly modifying factors in mind, it is believed, however, that certain general propositions may be formulated and regarded as fairly dependable:

(1) Weight and dimensions increase with age. Growth continues as in certain other mammals (for example, the gopher, *Thomomys*) practically through life.

(2) The number of scale-rows on the tail is apparently the same in adults and in juvenals, the increase in size taking place through an augmentation in measurements of the individual scales.

(3) The ratio of the length of the tail vertebrae to total length apparently increases with age (no. 12108 constitutes an apparent exception to this statement).

(4) There is evident a tendency for the tail to increase in width somewhat more rapidly than in length.

There is great individual variation in the ratio of the width of tail to length. According to the table, the maximum of this ratio is 51.0 percent, minimum 31.8, indicating a variation of 19.2 percent. The average of all the ratios is 41.3 percent. Although the animals presenting the highest ratios are adults, there is no very clear correlation between age and different proportional dimensions of tail.

Two specimens (nos. 71830, 71833, loaned by the Biological Survey), being younger than the youngest listed in the table, have ratios of 44 and 47 respectively.

Coloration and Pelage

On the whole, the coloration of the juvenals is very much like that of the adults. There is a change toward a deepening in general coloration, and a slight differentiation of color areas with increased age. In the adults there tends to be a dark area (one obtains a general impression of seal brown or a little paler) in the middle of the back, with a lightening of coloration (varying from near hazel or cinnamon-buff to chestnut) on the sides of the face, the top of the head, the nape of the neck, the shoulders and the rump. The pelage of the young is softer and fluffier than that of the adults.

No differences in relative amounts of underfur and overhair can be clearly correlated with age. No individual out of four juvenals at hand (nos. 12109, 12110, 12106, and 12105, taken June 20 to 27) has the overhair so worn as it is in certain adults (as nos. 12108 and 12107, taken June 25).

The coloration of the underfur changes little with age, varying above, in both old and young, from fuscous and fuscous-black to benzo and hair brown, and varying beneath about light drab and light cinnamon-drab. One adult specimen (no. 12101) has the underfur above an almost uniform drab.

Two very young juvenals, loaned by the Biological Survey (nos. 71830, 71833) are very similar to the juvenals mentioned above. Being younger, the hair of nos. 71830 and 71833 is noticeably shorter, softer, and fluffier. The only difference in coloration is a slightly darker general effect dorsally.

Dorsal coloration.—There is in the older animals a distinct darkening in dorsal appearance, the color varying from cinnamon to chestnut. This darkening is partly the result of darker coloration of individual hairs, and partly the result of the showing through to a greater degree of the dark underfur. The juvenals are pinkish cinnamon to cinnamon, sometimes a little darker dorsally.

The forefeet are near warm sepia or mars brown in the young, while in the older ones they have a deeper shade and exhibit something of a luster.

The hind feet of the young are near mars brown, although it is very difficult to fix the tone, while those of the adults are browner, varying from near carob brown to near hazel.

Ventral coloration.—The juvenals have more of a golden luster ventrally along the sides of the belly than the adults. The coloration mid-ventrally varies about drab in the juvenals, with a tendency to be darker in the adults. The area just anterior of the tail ventrally varies in the adult between cinnamon-brown and chestnut or bay, while in the juvenals it varies between walnut brown and cinnamon-buff.

Molt and range of individual variation.—Adequate material for the study of the molting process in beavers is lacking. It seems probable that the molt is not regional, as it is in chipmunks and gophers, but general, the hair being renewed gradually all over the body.

In some species there seems to be decided individual variation in coloration of pelage. Of the specimens from eastern Canada at hand, one (no. 4358, U. S. Nat. Mus., May 21) is in light pelage, while two (nos. 174525, 174526, U. S. Nat. Mus., Sept. 25) are in dark pelage. Among skins of *Castor canadensis phaeus* from Admiralty Island, one (no. 209, Mus. Vert. Zool., May 16) is very dark, while another (no. 210, Mus. Vert. Zool., June 1) is paler. Details of these differences appear in the tabulations of coloration in the following pages.

Tail.—The variation in measurements and proportions of tails is recorded in table I, p. 419.

Scattered hairs, which grow from between the scales, appear in the tails of the juvenals, but are generally lacking in those of the adults.

CRANIAL CHARACTERS

(See table, opp. p. 426, and fig. B, p. 424)

General Change

The skull is rounded in young animals, with frontals elevated, and interparietal region sloping. In adults it is more flattened, with frontals not elevated and interparietal region not sloping so much.

As growth continues, the comparatively undifferentiated skull of the juvenal becomes adapted to the increased strains put upon it, the sutures tend to disappear, the bones harden, processes and ridges develop greatly, and there is an increase in size.

Every bone changes somewhat in outline as the animal grows older, the most evident modifications being (*a*) loss by the frontals of their jardinier or vase-shape in outline as viewed dorsally, and their assumption of a fleur-de-lis shape, due to encroachment of temporal ridges anteriorly; (*b*) narrowing and antero-posterior extension of the interparietal, giving it, in outline as viewed dorsally, an Indian-club rather than a subrectangular shape; (*c*) change in outline of the palatine as viewed ventrally, so that instead of being nearly an equilateral triangle it is isosceles; (*d*) widening of the foramen magnum proportionally to its height.

Teeth

Milk Dentition and the Eruption of the Teeth

The dental formula of the beaver is $I\frac{1}{1}$, $C\frac{0}{0}$, $P\frac{1}{1}$, $M\frac{3}{3} \times 2 = 20$.

Fig. A. Occlusal surface of P^4, to show method of taking measurements. Approximately natural size.

Milk premolars are brachydont, usually with three well-developed roots, though in one specimen at hand there are two roots only. Tooth eruption is as follows: milk premolar 4; molar 1; molar 2; molar 3; permanent premolar 4. The order of appearance of the teeth is the same on both jaws, the corresponding upper and lower teeth appearing simultaneously.

II. MEASUREMENTS* OF TEETH OF *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA

(All measurements in millimeters)

Transverse†

Museum number	Sex	P^4	M^1	M^2	M^3	$P_{\overline{4}}$	$M_{\overline{1}}$	$M_{\overline{2}}$	$M_{\overline{3}}$	Basilar length of crania
12104	♂	5.7	5.8	5.2	5.2	4.8	5.6	5.8	5.2	99.6
12108	♀	4.7	6.2	5.8	5.4	4.8	6.2	6.2	5.5	100.6
12103	♀	5.2	5.7	5.3	5.2	5.0	5.9	5.8	5.3	103.9
12102	♂	5.2	6.0	5.8	5.4	5.2	6.2	6.4	5.7	105.8
12111	♂	7.7	7.4	6.7	6.0	6.7	7.7	7.4	6.2	110.9
12101	♂	8.4	7.7	6.9	6.1	7.0	7.5	7.0	6.2	111.9
12107	♀	7.7	7.4	6.5	6.2	6.8	7.6	7.0	6.2	122.6

Longitudinal†

Museum number	Sex	P^4	M^1	M^2	M^3	$P_{\overline{4}}$	$M_{\overline{1}}$	$M_{\overline{2}}$	$M_{\overline{3}}$	Basilar length of crania
12104	♂	5.5	6.1	5.6	5.3	6.1	7.0	7.2	6.8	99.6
12108	♀	5.7	5.9	5.5	5.3	6.1	7.4	7.1	6.8	100.6
12103	♀	5.4	6.0	5.4	5.2	6.1	6.7	6.7	6.8	103.9
12102	♂	5.6	6.0	5.7	5.3	6.6	6.9	7.0	7.2	105.8
12111	♂	7.4	6.4	6.3	6.1	8.9	7.6	7.9	7.5	110.9
12101	♂	7.6	6.5	6.7	6.5	9.0	8.0	8.1	7.3	111.9
12107	♀	8.2	6.9	6.2	5.9	9.0	7.5	7.5	7.6	122.6

*Each measurement is taken three times and the results averaged to give the measurement here entered.

†See figure A.

Some Characteristics of the Permanent Dentition

The permanent dental armature exemplifies a high degree of hypsodonty. The oldest crania available to the writer have the pulp-cavities of the cheek-teeth almost completely closed. In order to ascertain whether there is a pronounced change in size of teeth with age, all the cheek-teeth on the left-hand side, above and below, of seven available skulls from Vancouver Island, were measured. The skulls themselves belonged to animals of different ages. In nos. 12104,

Fig. B. Outline drawings to show some of the changes occurring with age in *Castor canadensis leucodonta*. Figures approximately two-thirds natural size.
a. Young animal; no. 12106, ♂, Alberni, Vancouver Island, British Columbia.
b. Older animal; no. 12102, ♂, Alberni, Vancouver Island, British Columbia.
c. Old adult beaver; no. 12107, ♀, Alberni, Vancouver Island, British Columbia.

12108, and 12103 the permanent premolar has hardly become functional. No. 12107 is the skull of a comparatively old adult, as shown by its dimensions and degree of development. To reduce the margin of error, each dimension was carefully taken three times, and the results averaged, in case they did not exactly agree (see table II).

It is apparent, from the data of the table of measurements, that all the cheek-teeth first increase in size with age, then undergo a slight absolute or proportional decrease. It should be noted that the initial increase is of greater magnitude than is the later decrease. The tooth pierces the gum, increases in size up to a certain point, then decreases *slightly*. Since the oldest skulls at hand, without exception, have the longest maxillary tooth-rows, the decrease in tooth dimension late in life is not sufficient to affect the validity of the "length of the maxillary tooth-row" as a comparative measurement.

The table of measurements indicates that there are no important differences in the relation of the antero-posterior to the transverse diameter of the teeth in crania of different ages. One notes that the relation of the longitudinal or antero-posterior diameter of the teeth to the transverse is more variable in the superior teeth than in the inferior, in which latter the antero-posterior diameter exceeds the transverse in nearly all cases.

A number of possibly significant conclusions are derivable from the tables of measurements of the teeth of beavers of different species (tables II and IV):

(1) All the superior molars measured have the transverse diameter equal to or exceeding the antero-posterior, except in the following cases: in no. 12104, Vancouver Island (M^1, M^2, M^3); no. 12103, Vancouver Island (M^1, M^2); no. 12111, Vancouver Island (M^3); no. 12101, Vancouver Island (M^3); no. 3672, Skagit River, Washington (M^3); in nos. 209 and 210, Admiralty Island (M^2, M^3).

(2) All the superior premolars measured have the antero-posterior diameters equal to or exceeding the transverse, except in the following cases: nos. 12101, 12104, 12111, Vancouver Island; nos. 174525, 174526, New Brunswick.

(3) Inferior molars in *leucodonta* have the antero-posterior diameter greater than the transverse (except M_1 in nos. 12111 and 12107, Vancouver Island).

(4) All the inferior premolars measured have the antero-posterior diameter greater than the transverse.

The Dental Armature as a Cutting and Grinding Agency

The work of the beaver, as exemplified in the cutting of materials for lodges and dams, serves to illustrate the efficiency of the incisors as cutting agents. The beaver's incisor is said to have been the hardest substance except flint known and used as a cutting tool by certain tribes of North American Indians. That the grinding portions of the beaver's dental armature are no less efficient to perform the function required of them is evident when it is considered that bark, a substance requiring very powerful mastication, is the beaver's principal food. Counting from front to back there are about 40 transverse cutting blades on each maxillary tooth-row, making 80 cutting blades for the upper teeth. A similar number obtains for the lower teeth. Only one side at a time can be opposed in the process of mastication, so that 40 blades above are brought against 40 blades below in the course of one chewing movement. If there is enough lateral motion during this movement, however, all 80 of the blades of the upper teeth may be ground against the 80 blades of the lower teeth. In the former case 80 cuts, in the latter 160, would be given to the mouthful of material. In case the beaver makes 100 chewing movements a minute, the number of cuts for that period would be in the former case 8000, in the latter 16,000.

Unfortunately, the writer has never been privileged to ascertain from watching the animal in life what the characteristic jaw movements are, nor have references to the matter been found in the literature examined. On the basis of the arrangement of the series of teeth with reference to one another it may be concluded, however, that there is an antero-posterior movement of probably 15 to 20 millimeters magnitude. That there is lateral motion is equally certain, although it must be much less than the antero-posterior. Eight millimeters appears to be about the maximum sidewise movement possible.

Parallelism in *Castor* and *Erethizon*

The general resemblance of the enamel pattern of the cheek-teeth obtaining between the genera *Castor* and *Erethizon* has been remarked by former workers. Another character, of interest in this connection, is the condition of the palato-maxillary region, which is rounded instead of plane in both genera. Authorities on classification agree in referring the beavers to the sciuromorph section of the Rodentia,

while the porcupine belongs to the section Hystricomorpha. If the above-mentioned resemblances are not due to inheritance from a common ancestor, and the bulk of evidence would seem to indicate that they are not, they illustrate a noteworthy case of parallel de-

IA

Museum number	Sex	LOC	Ratio maxillary tooth-row to basilar length	Ratio length of frontals to basilar length	Ratio length of interparietals to basilar length	Ratio mastoid width to basilar length	Ratio width of nasals to basilar length	Ratio vertical diameter of foramen magnum to basilar length
12109	?	Hall's Ranch,	.....	.....	.....	.....	.....	.....
12110	?	Hall's Ranch,	.....	.....	.....	.....	.....	.....
12106	♂	Hall's Ranch,	.....	36.7	23.2	57.8	20.7	17.6
12105	♀	Hall's Ranch,	.....	37.6	24.3	57.8	22.5	17.7
12104	♀	Hall's Ranch,	36.8	40.4	19.5	57.6	21.3	14.5
12108	♀	Hall's Ranch,	37.8	38.2	22.5	58.0	21.3	14.4
12102	♂	Hall's Ranch,	36.2	36.1	20.5	57.3	20.7	13.2
12103	♀	Hall's Ranch,	35.9	37.3	21.7	56.9	20.4	13.7
12101	♂	Hall's Ranch,	35.5	31.4	24.3	56.6	20.8	12.9
12111	♂	Great Central	35.6	39.1	22.0	56.6	20.9	13.2
12107	♀	Hall's Ranch,	35.4	31.9	21.5	56.7	19.8	11.3

*All measurements except as be
Width of nasals: across both n
Length of frontals: along inter
Length of interparietal: along
Length of nasals: measured, no

narrow tongue extends posteriorly of main posterior outline of bone.

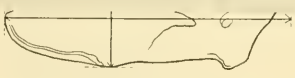

Fig. D. Lateral view of mandible, to show method of taking measurements. About one-half natural size.

tends to within 2.5 mm. of a line drawn at right angles to the antero-posterior axis of the skull at the narrowest part of the interorbital constriction.

Bailey (1905, p. 122) refers

III. CRANIAL MEASUREMENTS* OF *Castor canadensis leucodonta* FROM VANCOUVER ISLAND, BRITISH COLUMBIA

Specimens arranged approximately in order of age from top of table to bottom
(All measurements in millimeters)

Museum number	Sex	LOCALITY	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Length of frontals	Length of interparietals	Greatest length of mandible; angle to anterior surface of alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Most dorsal point on outline of foramen magnum to occipital crest on median line. (See fig. G)	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Ratio maxillary tooth-row to basilar length	Ratio length of frontals to basilar length	Ratio length of interparietals to basilar length	Ratio mastoid width to basilar length	Ratio width of nasals to basilar length	Ratio vertical diameter of foramen magnum to basilar length
12109	?	Hall's Ranch, Alberni Valley	.....	50.1	36.7	17.6	22.4	13.7	.....	22.7	16.2	55.1	26.6	8.0	.....	.....	.....	.....	.....	.....	.....	.....
12110	?	Hall's Ranch, Alberni Valley	.....	.....	.....	17.8	23.5	14.1	.....	24.1	15.9	58.9	28.0	8.7	.....	.....	.....	.....	.....	.....	.....	.....
12106	♂	Hall's Ranch, Alberni Valley	65.6	54.2	37.9	17.7	.....	13.6	.....	24.1	15.2	58.3	.....	8.7	11.5	14.5	.....	36.7	23.2	57.8	20.7	17.6
12105	♀	Hall's Ranch, Alberni Valley	66.3	55.7	38.4	18.0	24.7	14.9	.....	24.9	16.1	56.2	28.6	9.0	11.8	14.7	.....	37.6	24.3	57.8	22.5	17.7
12104	♀	Hall's Ranch, Alberni Valley	99.6	82.7	57.4	22.3	39.8	21.2	26.8	40.2	19.4	93.6	50.4	14.4	14.4	20.2	26.8	40.4	19.5	57.6	21.3	14.5
12108	♀	Hall's Ranch, Alberni Valley	100.6	88.2	58.3	24.8	40.6	21.4	27.8	38.4	22.6	95.7	52.3	12.9	14.5	19.5	27.8	38.2	22.5	58.0	21.3	14.4
12102	♂	Hall's Ranch, Alberni Valley	105.8	87.5	60.6	22.5	.....	21.9	27.7	38.2	21.7	94.5	51.2	14.2	14.0	20.2	26.2	36.1	20.5	57.3	20.7	13.2
12103	♀	Hall's Ranch, Alberni Valley	103.9	84.0	59.1	22.5	39.9	21.2	26.9	38.8	22.5	92.0	49.3	13.4	14.2	19.9	25.9	37.3	21.7	56.9	20.4	13.7
12101	♂	Hall's Ranch, Alberni Valley	111.9	94.7	63.4	23.9	46.6	23.3	28.6	35.1	27.2	101.5	57.1	15.4	14.3	17.2	25.5	31.4	24.3	56.6	20.8	12.9
12111	♂	Great Central Lake.....	110.9	91.6	62.8	24.4	45.2	23.2	28.4	43.3	24.4	97.4	59.6	18.1	14.6	18.5	25.6	39.1	22.0	56.6	20.9	13.2
12107	♀	Hall's Ranch, Alberni Valley	122.7	101.0	69.5	25.7	48.0	24.3	31.2	39.1	26.3	113.2	63.3	18.5	13.8	19.6	25.4	31.9	21.5	56.7	19.8	11.3

*All measurements except as below specified taken in accordance with methods given by Taylor, 1911, pp. 206, 207.
Width of nasals: across both nasals at right angles to the antero-posterior axis of skull, so as to include the most lateral points on their outline.
Length of frontals: along interlying suture, or where this is obscure, along median line of skull.
Length of interparietal: along median line of skull.
Length of nasals: measured, not strictly along interlying suture, but so as to include the most anterior and most posterior points, except where an exceedingly narrow tongue extends posteriorly of main posterior outline of bone.

THE DENTAL ARMATURE AS A CUTTING A

The work of the beaver, as exemplified i
for lodges and dams, serves to illustrate th
as cutting agents. The beaver's incisor i

obtaining between the genera *Castor* and *Ere*
by former workers. Another character, of
tion, is the condition of the palato-maxillary
instead of plane in both genera. Authoritie
in referring the beavers to the sciuromorph

while the porcupine belongs to the section Hystricomorpha. If the above-mentioned resemblances are not due to inheritance from a common ancestor, and the bulk of evidence would seem to indicate that they are not, they illustrate a noteworthy case of parallel development in these widely different sections of the Rodentia. It is doubtless something more than coincidence in this connection that the beaver and the porcupine are bark-feeders. The rounded instead of plane conformation of the palato-maxillary region, and the similar complication of the enamel pattern of the cheek-teeth, appear to be direct adaptations: the first to the stripping of bark from twigs and branches; the second to its effective mastication.

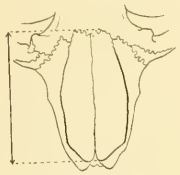

Fig. C. Rostrum, dorsal aspect, to show method of taking measurement "Length of nasals". About one-half natural size.

Dimensions of Crania

From the table of cranial characters (opp. p. 426) it appears that with age: (*a*) nearly every bone increases in size, each outside skull dimension becoming greater; (*b*) the ratio of the length of the interparietal to basilar length decreases (though no. 12101 departs rather widely from this rule); (*c*) the mastoid width increases at practically the same rate as does the basilar length, although giving evidence of a slight tendency to increase less rapidly.

Temporal Ridges

The degree of approximation of the temporal ridges is in general indicative of age, although the rate of approximation may vary in different forms. In *leucodonta* the temporal ridges first come together posteriorly, then continuously in an anterior direction. In the oldest skulls the ridges form a sagittal crest, narrow posteriorly, broader anteriorly, which extends to within 25 mm. of a line drawn at right angles to the antero-posterior axis of the skull at the narrowest part of the interorbital constriction.

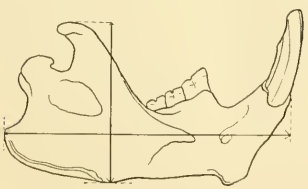

Fig. D. Lateral view of mandible, to show method of taking measurements. About one-half natural size.

Bailey (1905, p. 122) refers

IV. MEASUREMENTS* OF SUPERIOR CHEEK TEETH OF CERTAIN AMERICAN SPECIES OF BEAVERS

(All measurements in millimeters)

Museum number	Sex	SUBSPECIES	Length†				Width†			
			P^4	M^1	M^2	M^3	P^4	M^1	M^2	M^3
12654	♀	Castor subauratus subauratus	9.3	7.1	6.5	6.6	9.1	7.8	7.5	7.6
8988	♀	Castor subauratus subauratus	8.4	6.6	6.1	6.1	8.2	7.7	7.0	6.9
16383	♂	Castor subauratus subauratus	8.8	6.9	6.1	6.2	8.5	7.8	7.5	7.2
3672	?	Castor canadensis pacificus	9.4	7.6	7.1	7.3	9.1	8.3	7.7	6.9
12107	♀	Castor canadensis leucodonta	8.2	6.9	6.2	5.9	7.7	7.4	6.5	6.2
12101	♂	Castor canadensis leucodonta	7.6	6.5	6.7	6.5	8.4	7.7	6.9	6.1
60354	♂	Castor canadensis frondator	9.8	6.9	6.4	6.1	8.3	7.6	7.3	6.3
35946	♀	Castor canadensis frondator	8.1	6.3	6.0	5.8	7.8	7.1	6.5	5.9
4225	♂	Castor canadensis belugae	9.2	7.2	6.7	6.3	9.1	8.7	8.1	6.6
4220	♂	Castor canadensis belugae	8.7	7.0	6.4	6.1	8.6	7.9	7.6	6.9
4347	♂	Castor canadensis belugae	7.9	6.3	6.1	6.1	7.9	7.9	7.2	6.5
210	♂	Castor canadensis phaeus	8.8	7.1	6.5	6.4	7.9	7.9	6.6	6.1
209	♂	Castor canadensis phaeus	8.7	7.2	6.9	6.5	7.8	7.3	6.9	6.2
174525	♂	Castor canadensis canadensis	7.7	6.6	6.0	6.0	7.8	6.9	6.4	6.0
174526	♀	Castor canadensis canadensis	7.6	6.7	6.4	6.5	8.5	7.5	7.0	6.7

*In respect to these dimensions three possible sources of error should be noted: (1) The skulls may not be of precisely similar age; (2) in teeth of the shape of beaver's teeth it is hardly possible to be certain that a given measurement is taken always in precisely the same manner; (3) the teeth in skulls of comparable age may not represent exactly the same stage of wear. These considerations would seem to indicate that only the larger dimensional differences should be regarded as significant. The error has been avoided so far as possible (*a*) through selection of skulls of as nearly the same age as were available, (*b*) through one person taking all the measurements, and so far as possible at one sitting, and (*c*) through taking each measurement three times and averaging the results, where these did not agree. Errors in one direction are, moreover, likely to be balanced by those in the opposite direction.

†See figure A.

to the lyrate condition of temporal ridges as a character of *Castor canadensis texensis*. While it is probable that the character is of subspecific value in the Texan form of beaver, the fact that the material on which the description was based was exceedingly limited in amount emphasizes the alternative possibility that it is a character due to age only. Significant in this connection is the further fact that in the following forms the character is one the condition of which apparently depends solely on age: *Castor fiber, Castor canadensis phaeus, Castor canadensis belugae, Castor canadensis canadensis, Castor canadensis leucodonta,* and *Castor canadensis frondator.*

Fig. E. Outline of foramen magnum, to show method of taking measurements. About one-half natural size.

Description of a New Subspecies of Beaver from the Cook Inlet Region, Alaska

In the labor of allocation of specimens and determination of their status it soon became apparent that the skulls from Cook Inlet were somewhat different from those of any other race of beaver. Examination of additional comparable material confirms the differences first observed.

Castor canadensis belugae, new subspecies

Type.—Skull only, ♂ youngish adult, no. 4224, Mus. Vert. Zool.; Beluga River, Cook Inlet region, Alaska; "1907"; collected by Jacob Seminoff; orig. no. 2.

Diagnostic characters.—Perhaps nearest *Castor canadensis leucodonta* Gray, but crania immediately distinguishable through the narrower blades of the hamular processes of the pterygoids in *Castor canadensis belugae;* bony ridge laterally on rostrum less strongly developed in *belugae* than in *leucodonta; belugae* with tendency for maxillary tooth-row, and ratio of maxillary tooth-row to basilar length, to be greater.

Belugae is similar to *Castor canadensis canadensis* Kuhl, but with nasals of different outline, the lateral swelling being more posteriorly placed; maxillary tooth-row and ratio of maxillary tooth-row to basilar length tending to be greater.

External characters.—Only one skin of the new form (no. 4347,

Mus. Vert. Zool.) is at hand. For comparison of this with *Castor canadensis leucodonta* see below. A comparison with *Castor canadensis canadensis* is given in table opposite p. 432.

Range.—It is impossible at this time to define precisely the limits of range of *Castor canadensis belugae*. Specimens from the following localities have been examined: Beluga River (tributary to Cook Inlet from the north); Neuilchuk (sometimes spelled Ninilchik [Baker, 1906, p. 463], a village on eastern shore of Cook Inlet, south of the mouth of the Kasilof River); Kasiliff (probably Kasilof, a fishing village at the mouth of Kasilof River, Cook Inlet, according to Baker, 1906, p. 353); Snug Harbor, Alaska Peninsula (probably Snug Harbor on the western shore of Cook Inlet, near Iliamna Peak [Baker, 1906, p. 586]); and the general vicinity of Stuart Lake, British Columbia.

Fig. F. Outline of hamular process, showing method of taking measurement. About one-half natural size.

It is probable that the form occupies territory on the mainland from central British Columbia on the south to the Alaskan Mountains on the north. The main chain of the Rocky Mountains doubtless bounds its range on the east, and the ocean, or possibly certain coast mountains on the west.

This region is much interrupted topographically and it is not unlikely that adequate material would show considerable local differentiation, possibly the presence of well-marked subspecies, within its boundaries. Militating against this suggestion, however, is the observed similarity of specimens from such widely separated points as the Cook Inlet region, Alaska, and Stuart Lake, British Columbia.

Remarks

Comparison With *Castor canadensis leucodonta* Gray

The new subspecies, *belugae*, is perhaps nearest *leucodonta*, of which examples from Vancouver Island are at hand, although it is intermediate between that form and *canadensis* from eastern Canada. Crania can be distinguished from *leucodonta* by the narrower blades of the hamular processes of the pterygoids in *belugae* (see fig. F, above); by the ridge laterally on the rostrum less strongly developed than in *leucodonta;* by the tendency in *belugae* for maxillary tooth-row to be longer, shown also in ratio of maxillary tooth-row to basilar length.

Fig. G. Outline of posterior portion of cranium

e. Castor canadensis canadensis; inner line, no. 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick; outer line, no. 174525 ♂, U. S. Nat. Mus., same locality.

V. CRANIAL MEASUREMENTS* OF *Castor canadensis belugae* FROM COOK INLET REGION, ALASKA, AND BRITISH COLUMBIA, CANADA

Specimens arranged approximately in order of age from top of table to bottom

(All measurements in millimeters)

Museum number	Sex	LOCALITY	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Most dorsal point on outline of foramen magnum to occipital crest on median line. (See fig. G)	Vertical diameter of foramen magnum. (See fig. E)	Transverse diameter of foramen magnum	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio vertical diameter of foramen magnum to basilar length
4233	?	No data	100.1	82.7	55.7	20.9	38.5	19.2	28.6	.....	13.3	18.0	19.0	28.6	13.3
4226	♂	Beluga River, Cook Inlet region, Alaska	106.5	86.7	60.6	23.2	42.3	20.7	28.8	.....	14.7	18.8	19.4	27.0	13.8
4229	♂	Nenilchuk, Cook Inlet region, Alaska	106.9	86.5	.....	23.2	38.8	19.8	29.1	.....	12.7	18.8	18.5	27.2	11.9
4223	♀	Beluga River, Cook Inlet region, Alaska	108.5	86.9	57.3	24.0	40.6	20.7	29.1	.....	15.2	18.7	19.1	26.8	14.0
4230	♂	Nenilchuk, Cook Inlet region, Alaska	111.4	89.8	58.1	23.0	43.9	22.8	29.9	.....	13.0	16.6	20.5	26.8	11.7
4221	♂	Beluga River, Cook Inlet region, Alaska	112.3	92.0	63.5	23.6	43.6	21.1	29.9	.....	14.4	16.5	18.8	26.6	12.8
4222	♀	Beluga River, Cook Inlet region, Alaska	112.4	89.8	62.9	24.1	44.6	22.2	28.7	.....	13.8	18.1	19.7	25.5	12.3
4227	♂	Beluga River, Cook Inlet region, Alaska	119.9	97.0	66.6	24.3	49.5	22.7	30.9	.....	14.0	18.6	18.9	25.8	11.7
4224	♂	Beluga River, Cook Inlet region, Alaska	117.2	95.7	65.8	25.7	47.1	21.8	31.4	.....	14.6	19.2	18.6	26.8	12.5
4219	♂	Beluga River, Cook Inlet region, Alaska	116.0	95.6	66.3	26.5	47.0	22.4	31.4	.....	15.0	19.6	19.3	27.1	12.9
4232	?	Kasiliff, Cook Inlet region, Alaska	112.6	91.1	59.5	23.6	44.0	20.7	29.7	.....	11.0	17.4	18.4	26.4	9.8
4228	♂	Beluga River, Cook Inlet region, Alaska	116.2	.....	62.7	24.7	46.6	21.5	30.8	.....	14.8	17.7	18.3	26.5	12.7
4231	?	No data	110.9	91.5	61.4	23.5	45.8	22.0	30.1	.....	13.9	18.7	19.8	27.1	12.5
4225	♂	Beluga River, Cook Inlet region, Alaska	122.5	101.3	68.2	24.7	50.1	26.1	33.4	.....	13.6	18.7	21.3	27.3	11.1
4220	♂	Beluga River, Cook Inlet region, Alaska	118.0	96.5	69.6	26.6	47.9	24.1	30.7	.....	14.6	18.9	20.4	26.0	12.4
4347	♂	Snug Harbor, Alaska Peninsula, Alaska	109.9	90.3	61.7	20.9	44.6	21.9	29.6	.....	12.6	16.7	19.9	26.9	11.5
77159	♀	20 mi. E Stuart Lake, British Columbia	111.4	90.8	63.9	23.9	42.8	23.7	29.6	18.9	13.7	18.2	21.3	26.6	12.3
77147	♂	12 mi. N Stuart Lake, British Columbia	116.2	92.8	62.3	24.7	45.3	25.5	31.0	21.5	15.1	19.7	21.9	26.7	13.0
77157	♂	17 mi. N Stuart Lake, British Columbia	121.7	94.2	66.0	22.9	47.0	23.5	29.9	21.8	12.4	19.3	19.3	24.6	10.2
77158	♂	30 mi. E Stuart Lake, British Columbia	116.0	91.9	.....	22.7	46.9	24.8	31.8	22.4	15.0	20.8	21.4	27.4	12.4
77155	♂	15 mi. N Stuart Lake British Columbia	119.4	98.8	63.8	25.8	46.2	26.3	32.8	22.1	13.9	19.2	22.0	27.5	11.6
77150	♀	20 mi. NE Stuart Lake, British Columbia	119.2	94.3	65.9	22.7	49.2	23.9	29.7	21.5	16.1	20.2	20.0	24.9	13.5

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of the present paper.

Mus. Vert. Zool.) is at hand. For comparison of
canadensis leucodonta see below. A comparison
densis canadensis is given in table opposite p. 432.

row to be longer, shown also in ratio of maxillary to
length.

Fig. G. Outline of posterior portion of cranium of beaver, to illustrate method of measuring dorsal outline foramen magnum to inion, or most dorsal point on outline of foramen magnum to occipital crest on median line. About one-half natural size.

Belugae, on the basis of the table of measurements, has longer antero-posterior diameter of P^4 than in *leucodonta*, although specimens nos. 4347 from Cook Inlet and 12101 from Vancouver Island are nearly the same in this respect (see table IV, p. 428). *Belugae* generally has broader teeth transversely than in *leucodonta* (P^4 in specimen no. 12101, from Vancouver Island exceeds P^4 in no. 4347, from Cook Inlet).

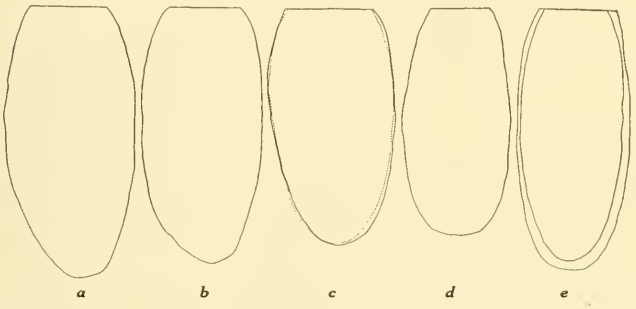

Fig. H. Outline drawings of tails of different races of western beavers. Approximately one-sixth natural size.

a. *Castor subauratus subauratus*, ♀, no. 12654, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

b. *Castor canadensis leucodonta*, ♀, no. 12107, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

c. *Castor canadensis phaeus;* solid line, no. 210, Mus. Vert. Zool., ♀, Hasselborg Lake, Admiralty Island, Alaska; dotted line, no. 209, Mus. Vert. Zool., ♂, Pleasant Bay, Admiralty Island, Alaska.

d. *Castor canadensis frondator*, ♀, no. 20751, U. S. Nat. Mus.; San Pedro River, Sonora, Mexico.

e. *Castor canadensis canadensis;* inner line, no. 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick; outer line, no. 174525 ♂, U. S. Nat. Mus., same locality.

Comparable skins of the two subspecies are distinguishable as follows: the single skin of *belugae* with both overhair and underfur thicker than in *leucodonta; belugae* paler in coloration than average of *leucodonta,* particularly about base of tail, which is near cinnamon-buff in *belugae,* varying from near hair brown to a shade between chocolate and bay in *leucodonta;* tails are similar in general outline.

Comparison With *Castor canadensis canadensis* Kuhl

Skulls of *belugae* comparable with *canadensis* as regards age have outline of nasals different; maxillary tooth-row longer in comparable crania; ratio of the maxillary tooth-row to basilar length averaging greater. *Belugae,* according to the table of measurements, has teeth tending to be broader and longer than in *canadensis.* A detailed comparison of external characters of the Cook Inlet race and *canadensis* will be found in table VII, opposite.

The following table illustrates differences in tail outline:

VI. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken from dry skins

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor canadensis belugae.....	4347	245	115	47.0
Castor canadensis canadensis..	4358	223	92	41.1
Castor canadensis canadensis..	174525	265	116	43.4
Castor canadensis canadensis..	174526	260	108	41.3

The tails of 4347 and 4358 were considerably crinkled and dried hard, so that their measurements are less dependable than those of the others.

Comparison with *Castor canadensis phaeus* Heller

Separated from *Castor canadensis phaeus* Heller, inhabiting Admiralty and probably neighboring Alaskan islands, on following characters: *belugae* with broader interorbital constriction than in *phaeus;* nasals of different outline, these bones not tapering caudad as they do in *phaeus;* nasals with lesser degree of extension back of a line joining the points of the antorbital tubercles. While individual specimens show intergradation in one or two of these characters, as might be anticipated, it is true that in the series at hand every specimen is clearly separable. Externally *belugae* is dis-

VII. COMPARISON OF EXTERNAL CHARACTERS OF *Castor canadensis phaeus* HELLER, FROM ADMIRALTY ISLAND, ALASKA, WITH *Castor canadensis belugae* TAYLOR, FROM COOK INLET REGION, ALASKA, AND WITH *Castor canadensis canadensis* KUHL, FROM EASTERN CANADA.

Points of Comparison	*Castor canadensis phaeus* (two examples)	*Castor canadensis belugae* (one example)	*Castor canadensis canadensis* (two examples)
General coloration	No. 210 similar in coloration to no. 4347 from Cook Inlet; no. 209 much darker; all the other specimens of *phaeus* similar to no. 209.	No. 4347 from Cook Inlet much like no. 210, somewhat paler; considerably lighter in coloration than the rest of the series of *phaeus*.	Similar to *phaeus* but no specimen as dark as no. 209.
Dorsal overhair	No. 210 with tips of dorsal overhair between cinnamon and sayal brown; no. 209 varying about seal brown.	No. 4347 cinnamon to ochraceous-tawny, so definitely lighter.	Hairs a mixture of blackish and ochraceous-tawny (nos. 174525, 174526), former the darker; general appearance near chocolate or bay.
Dorsal underfur	No. 210 benzo brown to bone brown; no. 209 light seal brown to benzo brown.	No. 4347 a slightly paler tint of benzo or bone brown than in no. 210.	Near clove brown (nos. 174525, 174526).
Overhair of sides	No. 210 with dark coloration of dorsal overhair grading into the verona brown or warm sepia of the ventral overhair with slight intermediate lightening; no. 209 cinnamon and sayal brown of dorsal overhair grading toward the verona brown of the ventral overhair.	No. 4347 with hair of sides approaching cinnamon and then grading into coloration of the underparts which is near army brown.	Overhair of sides tipped with cinnamon; broad area of intergradation between chocolate or bay dorsal coloration and warm sepia ventral coloration (nos. 174525, 174526).
Top of head	No. 210 orange-cinnamon; no. 209 mikado brown.	No. 4347 similar to rest of upperparts, but shade very slightly lighter, near orange-cinnamon.	Similar to rest of upperparts.
Sides of face	Nos. 210 and 209 cream-buff grading toward honey yellow.	No. 4347 cinnamon-buff and pinkish buff.	Near pinkish cinnamon (no. 174526); near cinnamon-buff or pinkish buff (no. 174525).
Base of tail above	No. 210 near bister, becoming paler anteriorly; no. 209 near warm sepia.	No. 4347 between clay color and cinnamon-buff.	Cinnamon-drab to verona brown; hairs immediately at base of tail tipped with seal brown (no. 174525); chestnut to bay, hairs at immediate base of tail tipped with seal brown (no. 174526).
Forefeet	No. 210 near cinnamon-drab; no. 209 cinnamon-drab to benzo brown.	No. 4347 pinkish buff mixed with a color near cinnamon-drab.	General impression pale brownish drab (no. 174525); approaching warm blackish brown (no. 174526).
Hind feet	Lighter than in *canadensis:* No. 210 near mars brown, burnt umber or Hay's brown; no. 209 deep brownish drab.	No. 4347 varying about cinnamon-drab and benzo brown.	Near dark vinaceous-drab (no. 174525); similar but with tendency to be lighter (no. 174526).
Ventral overhair	Nos. 210 and 209 varying about verona brown and warm sepia.	No. 4347 lighter than in *phaeus*, nearest army brown, Rood's brown, or benzo brown.	Bone brown, dark grayish brown, or dusky drab (no. 174525); a trifle paler, near dark vinaceous-drab or natal brown (no. 174526).
Throat band	No. 210 varying about cinnamon-buff, slightly paler dorsally, slightly darker ventrally; no. 209, scarcely indicated pinkish buff in coloration.	No. 4347 with few long hairs near cinnamon-buff; no definite throat band.	Definite throat band, the scattered lighter hairs being near cinnamon-buff (no. 174525); nearer ochraceous-buff (no. 174526).
Base of tail beneath	No. 210 hazel to chestnut; no. 209 varying about verona brown, warm sepia and mars brown.	No. 4347 between pinkish buff and cinnamon-buff.	Liver or carob brown approaching orange-cinnamon laterally and anteriorly (no. 174526); mixture of chestnut and cinnamon-drab approaching pinkish buff laterally and anteriorly (no. 174525).
Ventral underfur	No. 210 shaft of hair pale drab-gray, terminally approaching drab, general impression of light drab given; no. 209 similar, but general impression nearer light cinnamon-drab.	No. 4347 shaft of hair pale drab-gray, terminally ecru-drab to cinnamon-drab, general impression near ecru-drab.	Shaft of hair pale, nearest pale gull gray, tipped with drab-gray (nos. 174525, 174526).
Tail	Broader than in *canadensis*.	Narrower than in *phaeus*.	Narrower than in *phaeus*.

tinguished by slightly paler coloration. See table of color characters, table VII, opposite page 432.

Material

Twenty-two specimens, skulls only with one exception, partly from the collection of the Museum of Vertebrate Zoology, partly from that of the Biological Survey Collection in the U. S. National Museum: Beluga River, Cook Inlet region, Alaska, 10 (nos. 4219–4228, skulls only, Mus. Vert. Zool.); Nenilchuk or Ninilchik, east shore Cook Inlet, 2 (nos. 4229, 4230, skulls only, Mus. Vert. Zool.); Kasiliff (probably Kasilof), mouth of Kasilof River, Cook Inlet, 1 (no. 4232, skull only, Mus. Vert. Zool.); Snug Harbor, probably west shore Cook Inlet near Iliamna Peak, 1 (no. 4347, skin and skull, Mus. Vert. Zool.); and probably from Cook Inlet, no data attached, 2 (nos. 4231, 4233, skulls only, Mus. Vert. Zool.); 12 miles north Stuart Lake, British Columbia, 1 (no. 77147, skull only, U. S. Nat. Mus., Biol. Surv. coll.); 15 miles north Stuart Lake, 1 (no. 77155, skull only, U. S. Nat. Mus., Biol. Surv. coll.); 17 miles north Stuart Lake, 1 (no. 77157, skull only, U. S. Nat. Mus., Biol. Surv. coll.); 20 miles east Stuart Lake, 2 (nos. 77150, 77159, skulls only, U. S. Nat. Mus., Biol. Surv. coll.); 30 miles east Stuart Lake, 1 (no. 77158, skull only, U. S. Nat. Mus., Biol. Surv. coll.).

Description of a New Subspecies of Beaver from Eastern Shasta County, California

Certain crania of beavers obtained in California have recently been received from the Bureau of Biological Survey, of the United States Department of Agriculture. These belong to specimens collected at Cassel, on Hat Creek, a tributary of the Pit River, eastern Shasta County, California, which, while they are undoubtedly most closely related to *Castor subauratus subauratus* of the interior valleys of California, do present constant differences therefrom.

Castor subauratus shastensis, new subspecies

Type.—Skull only, ♂ adult; no. 50978, U. S. Nat. Mus., Biol. Surv. coll.; Cassel [Hat Creek], Pit River, Shasta County, California; January 3, 1893; collected by H. E. Williams.

Diagnostic characters.—No skins of the new form are available.

The outline of the nasals is distinctive. In *Castor subauratus shastensis* the nasals do not taper so regularly or rapidly posteriorly as in *Castor subauratus subauratus*. The lateral nasal outline is, in *shastensis*, invaded by the postero-medial portion of backward-extending tongue of the premaxilla. Consequently there is formed a "bay" in the lateral outline of the nasals posteriorly, which is lacking in *subauratus*. In one or two specimens of the latter there is a slight indication of such a relation, but the diagnostic value of the character as given, both in adult and young specimens of both species, holds in available material. The nasals tend to maintain their full breadth farther posteriorly in *shastensis* than in *subauratus*. The temporal ridges tend to form a distinct sagittal crest posteriorly and to show a higher degree of approximation anteriorly in *shastensis*, in specimens of the age which in *subauratus* exhibits a weak development of the crest posteriorly and a lyrate arrangement of the ridges anteriorly. Not only is there developed a distinct sagittal crest, but also a much more distinct knob dorsally on the crest located about 29 millimeters anterior of the posterior border of the lambdoidal ridge. The size of the cranium and the condition of certain sutures, whether open or closed, constitute the chief bases for age determination. Specimen no. 51477 of *shastensis*, which is considerably younger than specimen no. 12654 of *subauratus*, presents the same general arrangement of the temporal ridges. *Shastensis* no. 50979, which is certainly not older than specimen no. 12654 of *subauratus*, exhibits the characteristically distinct sagittal crest posteriorly and the higher degree of approximation anteriorly. The lambdoidal ridge is also more strongly developed in crania of nearly equal age. The use of these characters as subspecifically differentiatory might be unjustified without a mass of material, were they not correlated with others; for they undergo marked modification with age within the same subspecies. However, a different degree of development for the same age undoubtedly can be relied upon. In this case, although the available material is not sufficient to prove, for instance, that very old examples of *subauratus* would not show the distinct sagittal crest posteriorly, the higher degree of approximation of temporal ridges anteriorly, and the more strongly developed lambdoidal ridge, it does suffice to indicate a difference at least in rate of progress, and this difference is valid as a subspecific character.

The interorbital constriction is broader in *shastensis*. This meas-

urement in *shastensis* no. 50977 exceeds that in *subauratus* no. 12668, which has the same basilar length, by 8.9 percent. The difference holds throughout the series in specimens of comparable age.

The fronto-maxillary suture, situated dorsally on skull between backward-extending tongue of premaxilla and malar, is longer in *shastensis* than in *subauratus*. This holds for all specimens, regardless of age (see tables of measurements, pp. 436 and 449.)

The interparietal is somewhat broader in all specimens of *shastensis*, old and young, than it is in any specimen of *subauratus*.

Remarks.—The new subspecies, while clearly marked off from the beaver of the San Joaquin Valley by a number of valid cranial characters, nevertheless finds in the golden beaver its closest ally. This is shown by the facts that: (1) It is nearly identical with *Castor subauratus subauratus* in many cranial dimensions; (2) its foramen magnum shows the same general proportions; (3) its process medially in the interpterygoid fossa is nearly identical with that in *subauratus*, being different in form from that of any other west American beaver.

Cassel, Shasta County, California, the type locality of the new form, is situated on Hat Creek, a tributary of the Pit River, which is in turn a tributary of the Sacramento River. The two forms, *Castor subauratus subauratus* and *Castor subauratus shastensis*, are found in the same hydrographic basin, namely that draining into San Francisco Bay. It should be noted, however, that the type locality of the Shasta beaver is on the eastern slope of the main chain of the Sierra Nevada Mountains. The surrounding region is characterized by environmental conditions probably much more typical of the Great Basin faunal area than of those of the Sacramento Valley. It is entirely possible, if not probable, that the Pit River Narrows at present constitute a barrier not regularly crossed by beavers. The limits of the range of *Castor subauratus shastensis* are yet to be defined. There would seem to be a possibility that the beaver of the Great Basin will be found to be referable to it.

Material.—Five specimens, skulls only, all loaned to the writer by the authorities in charge of the Biological Survey mammal collection, United States National Museum: Cassel, Hat Creek, Pit River, Shasta County, California (nos. 50976–50979, 51477).

VIII. CRANIAL MEASUREMENTS* OF *Castor subauratus shastensis*, FROM CASSEL, SHASTA COUNTY, CALIFORNIA

Specimens arranged approximately in order of age from top of table to bottom

(All measurements in millimeters)

Museum number	Sex	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Length of fronto-maxillary suture†	Greatest length of mandible; angle anterior surface of alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio height of foramen magnum to basilar length
50977	♂	107.0	80.1	55.7	24.4	36.2	20.5	25.8	12.7	19.4	8.0	88.5	50.5	19.1	24.1	11.9
50976	?	95.5	78.8	53.1	24.4	34.8	21.8	26.3	12.0	18.1	7.0	86.4	49.9	22.8	27.5	12.6
51477	♂	121.7	98.3	70.5	29.7	48.3	26.2	33.4	13.6	20.6	7.3	107.1	63.1	21.5	27.4	11.2
50979	♀	122.8	99.6	69.3	30.1	49.2	27.7	33.0	11.5	19.1	6.1	106.5	65.7	22.6	26.9	9.4
50978	♂	128.0	104.8	70.7	30.5	50.6	29.1	35.2	11.1	19.0	7.9	112.6	67.1	22.7	27.5	8.7

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of present paper.

†Length of fronto-maxillary suture: taken in region of anterior root of zygomatic arch; fit one point of dividers into point of meeting of frontal, premaxilla, and maxilla; follow suture between maxilla and frontal laterad; adjust the other point of dividers at first point where maxilla touches jugal.

Comparisons of Certain American Beavers

Castor canadensis phaeus Heller, from Admiralty Island, Alaska

Material

Six specimens of *Castor canadensis phaeus*, skins with skulls, all in collection of Museum of Vertebrate Zoology: Hasselborg Lake, Admiralty Island, Alaska, 4 (nos. 129, 185, 210, 211); Mole Harbor, Admiralty Island, Alaska, 1 (no. 128); Pleasant Bay, Admiralty Island, Alaska, 1 (no. 209).

Three specimens of *Castor canadensis canadensis*, all from collection of Smithsonian Institution, United States National Museum: Nepisiquit River, New Brunswick, 2 (nos. 174525, 174526, skins with skulls); Moose River, Ontario, 1 (no. 4358, skin with cranium inside).

Comparison With *Castor canadensis canadensis* Kuhl, from Eastern Canada

General external characters.—Specimens compared: *Castor canadensis phaeus*, nos. 128 ♂, 129 ♂, 185 ♂, 209 ♂, 210 ♂, and 211 ♂, Mus. Vert. Zool., from three localities on Admiralty Island, Alaska, May 16 to June 1, 1907; and *Castor canadensis canadensis*, no. 4358 ♂, May 21, 1860, and nos. 174525 ♂, 174526 ♀, September 25, 1911; all U. S. National Museum coll. from eastern Canada.

In coloration the Admiralty Island skins as a series resemble the two specimens from New Brunswick, although the type of the Admiralty Island race (no. 209) is darker than either. No. 210 is a lighter example than the rest of the series of *phaeus*, with more cinnamon to sayal brown coloration dorsally. *Canadensis* no. 4358 is paler than the other specimens representing the same subspecies (nos. 174525, 174526).

The ratio of width of tail to its length in the two examples of *phaeus* (nos. 209, 210) is greater, as shown below, even than it is in the specimen of *frondator* at hand (no. 20751, U. S. Nat. Mus.), attaining 54.1 percent in no. 209. The widest part of the tail, however, is located more proximally in *phaeus* than it is in *frondator*.

For comparison of external characters, see table VII, opposite p. 432.

IX. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. phaeus	209	240	130	54.1
Castor c. phaeus	210	248	132	53.2
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	4358	223	92	41.1

General cranial characters.—(See table of measurements, opposite.) Crania compared: *Castor canadensis phaeus*, nos. 209 ♂, and 210 ♂, Mus. Vert. Zool., from Admiralty Island; and *Castor canadensis canadensis*, nos. 174525 ♂, 174526 ♀, U. S. Nat. Mus., from New Brunswick.

Interorbital constriction decidedly narrower in *phaeus*. Nasals in *phaeus* longer and narrower. Foramen magnum broader, the difference amounting to 13 and nearly 15 percent respectively in nos. 210 and 209, percentage taken on the basis of the average width in *canadensis*. Maxillary tooth-row longer in *phaeus*, consequently ratio of this measurement to basilar length greater. Teeth in *phaeus* with a tendency to be longer than in comparable skulls of *canadensis*.

Process in middle of interpterygoid fossa shorter in *phaeus*. Hamular processes of pterygoid (see fig. F, p. 430) broader-bladed in *phaeus* (no. 209, 4.1 mm.; 210, 4.1; no. 174525, 3.5; 174526, 3.1).

Chief points of difference: Narrower interorbital constriction (in *phaeus*), nasals of different length and outline, broader foramen magnum, longer maxillary tooth-row, longer teeth.

Comparison With *Castor canadensis belugae* Taylor, from the Cook Inlet Region

General external characters.—Specimens compared: *Castor canadensis phaeus*, nos. 128 ♂, 129 ♂, 185 ♂, 209 ♂, 210 ♂, and 211 ♂, Mus. Vert. Zool., from three localities on Admiralty Island, Alaska; *Castor canadensis belugae*, no. 4347 ♂, Mus. Vert. Zool., Snug Harbor, Alaska Peninsula. The specimens of *phaeus* were collected, as above stated, between May 16 and June 1. The single skin of *belugae* was secured June 14, 1904.

Specimens nos. 4347 and 210 are similar in coloration, the former being slightly paler. No. 209 is much darker than either, the rest of the series from Admiralty being nearest 209.

phaeus. Hamular blades (see fig. F, p. 430) broader (no. 210, 4.1 mm.; 209, 4.1. No. 4347, 2.5; 4225, 2.5; 4224, 3.1). Distance from most dorsal point on outline of foramen magnum to inion less (see fig. G, p. 431; no. 210, 19.4 mm.; 209, 17.1. No. 4347, 20.5 mm.; 4225, 22.4; 4224, 22.7).

X. COMPARATIVE MEASUREMENTS* OF ADULT SKULLS OF CERTAIN AMERICAN SPECIES OF BEAVER

(All measurements in millimeters)

Museum number	Sex	SUBSPECIES—GENERAL LOCALITY	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Greatest length of mandible; angle to anterior surface alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio vertical diameter of foramen magnum to basilar length
16383	♂	Castor subauratus subauratus (San Joaquin Valley, Calif.)	120.1	96.7	66.2	25.7	49.6	26.6	32.1	11.2	19.3	105.7	61.7	22.2	26.5	9.3
8988	♀	Castor subauratus subauratus (San Joaquin Valley, Calif.)	119.8	94.5	69.4	25.6	51.3	25.8	31.1	9.9	18.6	104.5	60.9	21.5	26.0	8.3
12654	♀	Castor subauratus subauratus (San Joaquin Valley, Calif.)	126.3	103.4	70.5	28.3	54.6	28.2	34.5	10.1	18.2	111.3	65.2	22.3	27.3	8.0
12101	♂	Castor canadensis leucodonta (Vancouver Id., B. C.)	111.9	94.7	63.4	23.9	46.6	23.3	28.6	14.3	17.4	101.5	57.1	20.8	25.5	12.9
12111	♂	Castor canadensis leucodonta (Vancouver Id., B. C.)	110.9	91.6	62.8	24.4	45.2	23.2	28.4	14.5	18.5	97.4	59.6	20.9	25.6	13.1
12107	♀	Castor canadensis leucodonta (Vancouver Id., B. C.)	122.7	101.0	69.5	25.7	48.0	24.4	31.2	13.8	19.9	112.5	63.3	19.8	25.4	11.2
4220	♂	Castor canadensis belugae (Cook Inlet Region, Alaska)	118.0	96.5	69.6	26.6	47.9	24.1	30.7	14.6	18.9	104.5	62.7	20.4	26.0	12.4
4347	♂	Castor canadensis belugae (Cook Inlet Region, Alaska)	109.0	90.3	61.7	20.9	44.6	21.9	29.6	12.6	16.7	95.7	55.0	19.9	26.9	11.5
4225	♂	Castor canadensis belugae (Cook Inlet Region, Alaska)	122.5	101.3	68.2	24.7	50.1	26.1	33.4	13.6	18.7	113.0	62.8	21.3	27.3	11.1
210	♂	Castor canadensis phaeus (Admiralty Id., Alaska)	117.6	97.1	64.2	20.8	51.7	22.8	32.5	14.3	19.7	113.0	61.1	19.4	27.6	12.2
209	♂	Castor canadensis phaeus (Admiralty Id., Alaska)	114.7	92.3	62.6	22.7	51.0	23.5	32.2	15.6	20.1	106.0	57.4	20.5	28.1	13.6
60354	♂	Castor canadensis frondator (Colorado River, Mex.)	118.7	96.8	65.3	25.0	49.3	24.8	32.7	14.7	17.1	.....	.....	20.9	27.5	12.4
35946	♀	Castor canadensis frondator (San Pedro River, Mex.)	111.7	94.3	61.3	21.8	46.3	22.4	29.5	14.8	18.3	102.0	57.4	20.1	26.4	13.2
174525	♂	Castor canadensis canadensis (New Brunswick, Canada)	117.6	95.2	63.0	24.5	48.2	24.5	29.1	13.9	17.1	102.0	57.6	20.9	24.8	11.8
174526	♀	Castor canadensis canadensis (New Brunswick, Canada)	115.2	92.7	64.6	24.5	47.9	25.2	29.2	14.7	17.7	105.0	60.6	21.9	25.3	12.8
18525	♀	Castor canadensis michiganensis (Michigan)	111.4	91.7	60.4	24.3	43.9	21.8	27.7	14.3	17.3	96.4	57.9	19.6	24.9	12.8
18526	♂	Castor canadensis michiganensis (Michigan)	111.5	89.2	61.5	23.0	.....	23.4	28.7	12.2	18.4	99.7	56.8	21.0	25.7	10.9
18527	♂	Castor canadensis michiganensis (Michigan)	108.5	87.9	60.9	23.7	43.4	22.0	26.9	14.4	18.4	96.6	57.2	20.3	24.8	13.3

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of present paper.

IX. Measurements and Ratios of Scaled

All measurements in millimeters, and taken in dry

Mus. Vert. Zool., from three localities on Adı
Castor canadensis belugae, no. 4347 ♂, Mus.
bor, Alaska Peninsula. The specimens of *ph*
above stated, between May 16 and June 1
belugae was secured June 14, 1904.

Specimens nos. 4347 and 210 are similar in coloration, the former being slightly paler. No. 209 is much darker than either, the rest of the series from Admiralty being nearest 209.

XI. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor canadensis phaeus	209	240	130	54.1
Castor canadensis phaeus	210	248	132	53.2
Castor canadensis belugae	4347	245	115	47.0

General cranial characters.—Crania compared: *Castor canadensis belugae*, nos. 4219-4233, 4347, Mus. Vert. Zool., all from the Cook Inlet region, Alaska; *Castor canadensis phaeus*, nos. 209 ♂, 210 ♂, Mus. Vert. Zool., from Admiralty Island. Specimens 209 and 210 from Admiralty Island, and specimens 4220, 4225 and 4347 from Cook Inlet comparable as to age.

Skulls of *phaeus* slightly smaller than the average of those of *belugae*. Interorbital constriction narrower in *phaeus* than in eighteen of the twenty-two specimens of *belugae* of all ages figured. Nasals longer, more tapering posteriorly. Sharp process medially in interpterygoid fossa reduced in *phaeus*. Foramen magnum averaging broader in *phaeus*. Vertical diameter of foramen magnum in no. 209 exceeding that in any specimen from Cook Inlet, but itself exceeded by no. 77150 from Stuart Lake, British Columbia. Teeth narrower in *phaeus*, proportionally to their length. Maxillary tooth-row averaging longer, consequently ratio of maxillary tooth-row to basilar length greater in *phaeus*. No. 4233, the youngest cranium from Cook Inlet, furnishes the single exception to this rule. In this specimen the ratio of maxillary tooth-row to basilar length is greater than in no. 210. Coronoid process of mandible lighter in *phaeus*. Lateral ridge on rostrum larger in *phaeus*. Hamular blades (see fig. F, p. 430) broader (no. 210, 4.1 mm.; 209, 4.1. No. 4347, 2.5; 4225, 2.5; 4224, 3.1). Distance from most dorsal point on outline of foramen magnum to inion less (see fig. G, p. 431; no. 210, 19.4 mm.; 209, 17.1. No. 4347, 20.5 mm.; 4225, 22.4; 4224, 22.7).

CASTOR CANADENSIS LEUCODONTA GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA

Material

Sixteen specimens, skins with skulls, and skulls only, partly from the Museum of Vertebrate Zoology and partly from the United States National Museum, Biological Survey collection: Hall's Ranch, Alberni Valley, Vancouver Island, British Columbia, 10 (nos. 12101–12110, skins with skulls, Mus. Vert. Zool.); Great Central Lake, Vancouver Island, British Columbia, 1 (no. 12111, skin with skull, Mus. Vert. Zool.); San Josef River Valley, Vancouver Island, British Columbia, 5 (nos. 140569–140573, skulls only, U. S. Nat. Mus., Biol. Surv. coll).

Comparison With *Castor canadensis canadensis* Kuhl, from Eastern Canada, and *Castor canadensis phaeus* Heller, from Admiralty Island

General external characters.—Specimens compared: *Castor canadensis leucodonta*, nos. 12101–12111, Mus. Vert. Zool., all but the last (which is from Great Central Lake, Vancouver Island) are from Alberni, Vancouver Island, British Columbia, June 11–27, August 25, 1910; *Castor canadensis canadensis*, nos. 4358 ♂, U. S. Nat. Mus., Moose River, Ontario, Hudson Bay region, May 21, 1860; nos. 174525 ♂, and 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick, Sept. 25, 1911; *Castor canadensis phaeus*, no. 128 ♂, Mole Harbor; nos. 129 ♂, 185 ♂, 210 ♂, 211 ♂, Hasselborg Lake; no. 209 ♂, Pleasant Bay; all Admiralty Island, Alaska, in Mus. Vert. Zool.

A specimen of *leucodonta* taken in August (no. 12111) is very similar in general coloration to the September examples of *canadensis* from New Brunswick. The resemblance in coloration of the hair dorsally is close. Coloration beneath different, varying about hair brown in *leucodonta*, near bone brown, dark grayish brown, dark vinaceous-drab or natal brown in *canadensis*. The difference in ventral coloration is more marked between no. 12111 and no. 174525, which is darker, than between no. 12111 and no. 174526, which is paler. The Vancouver Island series is not comparable with the Moose River example of *canadensis* (no. 4358). The overhair of the latter beneath is darker than in *leucodonta*, while the underfur beneath is paler. The fact that there has been much fading, however, renders comparisons taking account of no. 4358 of dubious value.

12111	110.9	18.1
12107	122.7	18.5
174525	117.6	20.9
174526	115.2	19.9

XII. COMPARISON OF EXTERNAL CHARACTERS OF *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA, WITH *Castor canadensis pacificus* RHOADS, FROM WASHINGTON STATE, *Castor canadensis canadensis* KUHL, FROM EASTERN CANADA, AND *Castor canadensis phaeus* HELLER, FROM ADMIRALTY ISLAND, ALASKA

Points of Comparison	*Castor canadensis leucodonta* (six examples)	*Castor canadensis pacificus* (one example)	*Castor canadensis canadensis* (two examples)	*Castor canadensis phaeus* (two examples)
Amount of pelage	Medium.	Heavier pelage than in *leucodonta*.	Heavier pelage than in *leucodonta*.	Heavier pelage than in *leucodonta*.
General coloration	Paler than in *canadensis* or *phaeus*.	Paler than in *leucodonta*.	Darker.	Darker.
Dorsal overhair	Varying about cinnamon-buff; no. 12108 with liberal insprinkling of seal brown hairs.	Varying from cinnamon in the middle of the back to lighter tints both anteriorly and posteriorly, attaining a pinkish buff color above the tail and on the cheeks.	Similar to *phaeus* but no specimen as dark as no. 209. Hairs a mixture of blackish and ochraceous-tawny (nos. 174525, 174526); general appearance near chocolate or bay.	No. 210, between cinnamon and sayal brown; no. 209, seal brown, clove brown or blackish.
Dorsal underfur	Varying from fuscous and fuscous-black to benzo and hair brown.	Varying about brownish drab.	Near clove brown (nos. 174525, 174526).	Benzo brown to bone brown (no. 210); light seal brown to benzo brown (no. 209).
Top of head	Not conspicuously different from rest of dorsal coloration.	Somewhat lighter than middle of back. Difference not conspicuous.	Similar to rest of upper parts.	Conspicuously different from rest of dorsal coloration. Orange-cinnamon (no. 210); mikado brown (no. 209).
Ventral overhair	Lighter than in *phaeus;* varying about hair brown.	Cinnamon-drab to light cinnamon-drab.	Bone brown, dark grayish brown, or dusky drab (no. 174525); a trifle paler, near dark vinaceous-drab or natal brown (no. 174526).	Darker than in *leucodonta*. Varying about verona brown and warm sepia (nos. 209 and 210).
Hind feet	Paler brown than in *canadensis*, varying from near carob brown to near hazel.	Close to benzo brown.	Near dark vinaceous-drab (no. 174525); similar but with tendency to be paler (no. 174526).	Lighter than in *canadensis*. Near mars brown, burnt umber or Hay's brown (no. 210); deep brownish drab (no. 209).
Base of tail above	Varies from near hair brown (no. 12111), to a shade between chocolate and bay (no. 12107); fringe of hairs near dark vinaceous-drab in several specimens (notably nos. 12108, 12101, 12102).	Varies from the fringe of cinnamon-drab or benzo brown hairs to cinnamon-buff or even to pinkish buff ten cm. anteriorly of base of scaled portion of tail.	Cinnamon-drab to verona brown; hairs at immediate base of tail tipped with seal brown (no. 174525); chestnut to bay; hairs at immediate base of tail tipped with seal brown (no. 174526).	Bister immediately at base, becoming paler anteriorly (no. 210); near warm sepia (no. 209).
Base of tail beneath	Between cinnamon-brown and chestnut or bay.	Cinnamon-buff to pinkish buff, with a wash of cinnamon-drab close to base of scaled portion of tail.	Mixture of chestnut and cinnamon-drab, approaching pinkish buff laterally and anteriorly (no. 174525); liver or carob brown approaching orange-cinnamon laterally and anteriorly (no. 174526).	Hazel to chestnut (no. 210); varying about verona brown, warm sepia and mars brown (no. 209).
Throat band	Inconspicuous; the few hairs present vary about warm buff.	Inconspicuous; lacking as a band.	Definite throat band near cinnamon-buff (no. 174525); nearer ochraceous-buff (no. 174526).	Varying about cinnamon-buff, slightly paler dorsally, slightly darker ventrally (no. 210); few scattered pinkish buff hairs (no. 209).
Tail	Intermediate in width in proportion to length, between *canadensis* and *phaeus*.	Narrower proportionally than in any of the others.	Narrower in proportion to length than in either *leucodonta* or *phaeus*.	Broader than in either *leucodonta* or *canadensis* in proportion to length.

underfur beneath is paler. The fact th
fading, however, renders comparisons tak
of dubious value.

In general, the table of comparisons (see table XII, opposite p. 440) shows *leucodonta* to be paler than *phaeus*.

Difference in amount of hair is marked. The pelage is lighter weight in *leucodonta* than it is in either *phaeus* or *canadensis*.

XIII. Measurements and Ratios of Scalded Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. leucodonta	12101	237	120	51.0
Castor c. leucodonta	12111	243	108	44.6
Castor c. leucodonta	12107	270	124	46.0
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	4358	223	92	41.1
Castor c. phaeus	209	240	130	54.1
Castor c. phaeus	210	248	132	53.2

General cranial characters.—Crania compared (being of approximately same age): nos. 12101 ♂, 12107 ♀, 12111 ♂, Mus. Vert. Zool., from Vancouver Island; nos. 174525 ♂, 174526 ♀, U. S. Nat. Mus., from New Brunswick; nos. 209 ♂, 210 ♂, Mus. Vert. Zool., from Admiralty Island.

Leucondota (see tables of measurements, opp. pp. 426 and 438) is separated from *canadensis* by the following characters: External outline of nasals different, tending to be more parallel in *leucodonta* than in *canadensis*, in which there is a dilation in the outline anteriorly; foramen magnum slightly broader in *leucodonta;* hamular processes (see fig. F, p. 430) definitely broader bladed in *leucodonta* (no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8. No. 174525, 3.5; 174526, 3.1).

Distance between most dorsal point on curve of foramen magnum and point of junction of lambdoidal ridge and sagittal crest (inion, see fig. G, p. 431) greater in the eastern subspecies, as shown by the following figures:

XIV. Measurements, Foramen Magnum to Inion

Specimen number	Measurements in millimeters: Basilar length of Hensel	Distance foramen magnum to inion
12101	111.9	15.4
12111	110.9	18.1
12107	122.7	18.5
174525	117.6	20.9
174526	115.2	19.9

C. c. leucodonta is separated from *C. c. phaeus* by the following characters: Nasals less tapering posteriorly and shorter in *leucodonta;* interorbital constriction broader; foramen magnum narrower (exception, *phaeus* no. 210 has a narrower foramen magnum than *leucodonta* no. 12107); maxillary tooth-row shorter in *leucodonta;* ratio of maxillary tooth-row to basilar length less; palate anteriorly (see fig. I) broader (no. 12107, 6.9 mm.; 12101, 6.9; 12111, 6.8. No. 209, 5.6 mm.; 210, 5.1); blade of hamulars (see fig. F, p. 430) slightly broader (no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8. No. 209, 4.1; 210, 4.1).

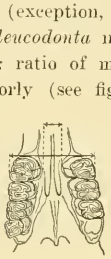

Fig. 1. Ventral aspect of palate, to show method of taking measurements. Shorter measurement is "palate anteriorly". Longer dimension is that to show the tooth-flare. Approximately one-half natural size.

CASTOR CANADENSIS PACIFICUS RHOADS, FROM THE MAINLAND OF BRITISH COLUMBIA AND WASHINGTON

Material

Eleven specimens, all from the collections contained in the U. S. National Museum: Puget Sound, 1 (no. 3936, jaws only); Skagit River [Washington], 1 (no. 3672[1], skull only); Lake Cushman, Mason County, Washington, 8 (nos. 71276, 71812, 71814, 78395, 87628, 87629, skulls only, and nos. 71830, 71833, skins only, Biol. Surv. coll., in U. S. Nat. Mus.); Keechelus Lake, Washington, 1 (no. 126190, Biol. Surv. coll.); Fisher, Five River Valley, Oregon, 2 (nos. 136605, 136606, skulls only, Biol. Surv. coll.).

Comparison With *Castor canadensis leucodonta* Gray, from Vancouver Island, and With Certain Other Species of Beavers

General external characters.—Material representative of external characters is limited. One young topotype skin of *Castor canadensis pacificus* Rhoads, from Lake Keechelus, Washington, is at hand. According to the label it was probably taken in February, 1903. No example of *Castor canadensis leucodonta* strictly corresponding in age and season with this topotype of *pacificus* is at

[1] This skull was specified by Allen (1877, p. 441) as from Europe, and was commented upon as presenting an exceptional character.

hand. Nearest in these respects are nos. 12103, 12104, from Hall's Ranch, Alberni Valley, Vancouver Island, taken June 15 and 18, respectively, 1910. As regards change in external characters with age, it should be called to mind that the modifications are not great in the material worked over (see p. 420). Respecting seasonal change our knowledge is less complete.

In *Castor c. leucodonta* the dorsal overhair appears darker than in *Castor c. pacificus* (see table XII, opposite p. 440, for comparison of characters). The general coloration belongs to the cinnamon series in both. The darker impression doubtless is the result of the presence in *leucodonta* of more dark hairs sprinkled in with the light, as, for example, in no. 12108. In *leucodonta* the dorsal underfur is a darker shade of brown than it is in *pacificus*.

Ventral coloration shows the same general relation, having a darker cast in *leucodonta* than in *pacificus*. The overhair ventrally is in *leucodonta* about as much darker than it is in *pacificus* as benzo brown is darker than cinnamon-drab. No color difference as regards underfur ventrally could be distinguished. The difference in coloration extends to the feet. The hind feet are hazel to carob brown in *leucodonta*, while in *pacificus* they are close to benzo brown.

General cranial characters.—Nasals in *Castor c. leucodonta* give the impression of being longer and narrower than in *pacificus*, though the measurements show the reverse to be true in the matter of length. Nasals in *pacificus* have their outlines somewhat more invaded laterally by the backward-extending tongues of the premaxillaries. This lateral invasion of the nasal outline occurs at a point farther anteriorly in *pacificus* than it does in either *leucodonta* or *belugae*. Beginning at the anterior end of the skull, and proceeding posteriorly, the nasal outlines are at first nearly parallel, then the premaxillaries interrupt the outline, and the nasals become somewhat narrowed, their lateral outlines again attaining a nearly parallel relation. This posterior parallel portion of the outline is longer in *pacificus* than in *leucodonta*. Looking at the crania in their anterior aspect there is manifest a tendency for the nasals to fall away in a regular curve from the median line. In *leucodonta*, on the other hand, the usual condition is a flattish area dorsally on the median line. In the mainland examples the nasals extend farther down on the side of the rostrum anteriorly, showing a condition which may be described as a droop. The nasals as a rule do

not extend posteriorly of a line connecting antorbital tubercles in either *leucodonta* or *pacificus*.

The lateral ridge on rostrum is more prominent in *leucodonta* than in *pacificus*.

The hamular blades are broad in *leucodonta* (see fig. F, p. 430); narrow in the Lake Cushman examples, and tending to show an intermediate condition in *Castor c. belugae* from Stuart Lake. Broad in two juvenals from Fisher, Oregon (nos. 136605, 136606) as well as in a young topotype skull of *pacificus* from Lake Keechelus, Washington. Measurements: *Castor c. leucodonta,* Vancouver Island, no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8; *Castor c. pacificus,* Lake Cushman, Washington, no. 71814, 2.2 mm.; 87629, 2.8; *Castor c. belugae,* Stuart Lake, British Columbia, no. 77155, 3.1 mm.; 77150, 3.2; the two juvenals from Fisher, Oregon: no. 136605, 4.3 mm.; 136606, 3.8; the young topotype cranium of *Castor c. pacificus:* no. 126190, 4.3. In *leucodonta* this character varies little with age. That it may do so in other subspecies, however, is indicated by the fact that a young specimen of undoubted *Castor canadensis frondator* (no. 60355), has broad-bladed hamulars, while an older specimen of the same subspecies (no. 35946) has narrower ones.

The occipital crest is flattened in *leucodonta*, upright in all but one of the specimens of *belugae* from Stuart Lake, British Columbia, and in a majority of those of *pacificus* from Lake Cushman, Washington. The disparity between *pacificus* and *leucodonta* in this respect is shown by the measurements given in the tables (p. 445, and opp. p. 426) under the heading "most dorsal point on the outline of foramen magnum to occipital crest on the median line" (see fig. G, p. 431). To make the comparison fair, only the three oldest crania of *leucodonta* (nos. 12111, 12101 and 12107) should be taken into account.

The foramen magnum is similar in general shape. Range of the ratio of vertical diameter of foramen magnum to basilar length: In *belugae,* with old and young crania represented, 9.8 percent to 14 per cent; in *pacificus,* with adult skulls only represented, 9.0 per cent to 12.5 per cent; in *leucodonta,* with old and very young skulls represented, 11.3 per cent to 17.7 per cent.

The specimens from the mainland of British Columbia and Washington are clearly set off from *Castor canadensis canadensis* and its close relative *C. c. michiganensis* through the characters of

XV. CRANIAL MEASUREMENTS* OF *Castor canadensis pacificus* FROM THE MAINLAND† OF WASHINGTON STATE

(All measurements in millimeters)

Museum number	Sex		Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Most dorsal point on outline of foramen magnum to occipital crest on median line. (See fig. G)	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Ratio vertical diameter of foramen magnum to basilar length	Ratio maxillary tooth-row to basilar length	Ratio width of nasals to basilar length
78395	♂	.....	116.7	92.1	65.2	24.1	50.1	22.7	30.5	20.7	14.5	19.6	12.4	26.1	19.5
71812	♂	.....	118.7	94.3	64.2	24.9	49.3	22.6	29.3	19.1	13.1	18.9	11.0	24.7	19.0
87628	♀	.....	118.5	95.3	64.6	23.7	48.4	22.6	30.0	20.3	13.3	17.7	11.2	25.3	19.1
3672	?	.....	125.7	.....	66.5	25.5	50.6	25.3	31.2	22.0	14.2	20.4	11.3	24.8	20.1
71814	♀	.....	118.7	94.2	67.4	24.7	49.9	24.0	29.9	20.7	14.8	19.3	12.5	25.2	20.2
71276	♀	.....	124.7	95.1	68.2	26.9	48.8	23.7	31.6	20.8	11.2	18.7	9.0	25.3	19.0
87629	♂	.....	124.9	.....	68.4	25.5	51.7	25.1	32.9	21.5	14.8	19.4	11.8	26.3	20.1

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of the present paper.

†All from Lake Cushman, Mason County, except no. 3672, which is from Skagit River.

certain cranial dimensions, condition of median process of interpterygoid fossa, and outline of nasals.

CASTOR SUBAURATUS SUBAURATUS TAYLOR, FROM THE SAN JOAQUIN VALLEY, CALIFORNIA

Material

Eleven specimens, skins with skulls, in collection of Museum of Vertebrate Zoology: Westley, near Grayson, Stanislaus County, California, 1 (no. 8869); Grayson, Stanislaus County, 2 (nos. 8987, 8988); Tuolumne River, 5 miles north of Grayson, 2 (nos. 12668, 12669); San Joaquin River, 5 miles north of Grayson, 1 (no. 12654); San Joaquin River, 10 miles north of Grayson, 4 (nos. 16382–16385); "Sespe River, Ventura County, California", locality possibly erroneous, 1 (no. 4918, skull only).

Comparison With *Castor canadensis pacificus* Rhoads, from Washington State, and *Castor canadensis frondator* Mearns, from the Colorado and San Pedro Rivers, Mexico.

General external characters

Specimens compared.—Castor subauratus subauratus, nos. 8869, 8987, 8988, 12654, 12668, 12669, 16382–16385, Mus. Vert. Zool., all from the general vicinity of Grayson, San Joaquin River, Stanislaus County, California, taken November 22 to March 25; *Castor canadensis pacificus,* no. 126190, U. S. Nat. Mus., Keechelus Lake, Washington, February (?), 1903; *Castor canadensis frondator,* no. 20751, U. S. Nat. Mus., San Pedro River, Sonora, Mexico, October 14, 1892.

Comparative material illustrative of external characters is inadequate, as the list of specimens compared shows. While of *subauratus* there is a good series, one skin only of *pacificus* is available, and this is representative of a young individual. The single specimen of *frondator* is an adult. Fortunately all the skins were taken during the winter months, so seasonal discrepancy is eliminated.

The California skins have less hair above than has the example of *pacificus.* Several of them have thinner hair below, also.

Coloration in *subauratus* is remarkably close to that in *pacificus* as illustrated in the material here compared. The color of the Lake Keechelus example has a slightly paler cast than that of the average of *subauratus,* for the reason that the overhair of the example of

XVII. EXTERNAL MEASUREMENTS* OF *Castor subauratus subauratus*, FROM STANISLAUS COUNTY, CALIFORNIA

XVI. COMPARISON OF EXTERNAL CHARACTERS OF *Castor subauratus subauratus* TAYLOR, FROM THE SAN JOAQUIN VALLEY, CALIFORNIA, WITH *Castor canadensis pacificus* RHOADS, FROM LAKE KEECHELUS, WASHINGTON, AND WITH *Castor canadensis frondator* MEARNS, FROM THE SAN PEDRO RIVER, MEXICO

Points of Comparison	*Castor subauratus subauratus* (ten examples)	*Castor canadensis pacificus* (one example)	*Castor canadensis frondator* (one example)
General coloration	Medium pale.	Similar to *subauratus*, perhaps slightly paler than the average of the series.	Paler than in *subauratus*.
Dorsal overhair	Cinnamon to light pinkish cinnamon; possessing luster in strong light which is not so evident in other forms.	Varying from cinnamon in the middle of the back to lighter tints both posteriorly and anteriorly, attaining a pinkish buff color above the tail and on the cheeks.	Varying about cinnamon.
Dorsal underfur	Varying about dark purple-drab, dark vinaceous-drab, dusky brown, and dark grayish brown.	Varying about brownish drab.	Pale tints of the drab series, near cinnamon-drab, light cinnamon-drab and light drab.
Whiskers	Varying from cream color and light buff to somewhat darker shades of the series.	Near deep brownish drab.	Clay color and darker.
Forefeet	Varying from vinaceous-buff, avellaneous, and wood brown, to fawn color, deep olive-buff, and even warm buff.	Near avellaneous or wood brown.	Mixture of colors which in combination approach clay color and hazel.
Hind feet	Varying about benzo brown; no. 12654 near chestnut.	Close to benzo brown.	Mixture of colors close to clay color and chestnut-brown; the chestnut-brown more in evidence than the clay color, making foot appear darker.
Ventral overhair	Varying about benzo brown; approaching light buff about fore limbs. Luster in evidence.	Cinnamon-drab to light cinnamon-drab.	Close to cinnamon-buff.
Ventral underfur	Varying about pallid vinaceous-drab.	Drab-gray to pale ecru-drab.	Decidedly lighter than in *subauratus;* approaching pale ecru-drab and pale drab-gray.
Base of tail above	Varying about cinnamon; range of variation approximately between pinkish cinnamon and cinnamon-rufous.	Varying from the fringe of cinnamon-drab or benzo brown hairs to cinnamon-buff or even to pinkish buff ten cm. anteriorly of base of scaled portion of tail.	A fringe of hairs at immediate base of tail colored near hazel and chestnut-brown.
Base of tail beneath	Rather narrow zone of hairs varying between pinkish cinnamon and chestnut; in some specimens there seems to be little difference in coloration between rest of underparts and base of tail.	Cinnamon-buff to pinkish buff, with a wash of cinnamon-drab close to base of scaled portion of tail.	Broad area at immediate base of tail and extending somewhat anteriorly from it colored near hazel and chestnut-brown.
Tail	Proportionally broader than in *pacificus*, narrower than in *frondator*.	Averages narrower proportionally than in either of the other species.	Averages broader proportionally than in either *subauratus* or *pacificus*.

certain cranial dimensions, condition of median pterygoid fossa, and outline of nasals.

of *subaurulus*, for the reason that the overha

XVII. EXTERNAL MEASUREMENTS* OF *Castor subauratus subauratus*, FROM STANISLAUS COUNTY, CALIFORNIA

Specimens arranged approximately in order of age from the top of table to bottom

(All measurements in millimeters)

Museum number	Sex	LOCALITY	Total length	Tail vertebrae	Hind foot	Ear†	Length, scaled portion of tail	Width, scaled portion of tail	Weight in pounds	Ratio width scaled portion of tail to length
16384	♂	10 mi. N. Grayson	834	391	155	27	234	88		37.6
12668	♂	5 mi. N. Grayson	960		170		265		21	
16385	♂	10 mi. N. Grayson	1064	493	185	31	298	124		41.6
16382	♀	10 mi. N. Grayson	1108		190		305	137		45.0
8987	♀	3 mi. N. Grayson	1038		192					
12669	♀	5 mi. N. Grayson	1090		185		282		27.5	
16383	♂	10 mi. N. Grayson	1118	513	187	35	311	133		42.8
8988	♀	Grayson	1135	360	195		310	140		45.2
12654	♀	5 mi. N. Grayson	1171		196	31	320	139	39.5‡	43.4

*For method of taking measurements see Taylor, 1911, p. 207.
†From crown of head to tip of ear, measured on medial surface of pinna.
‡Entrails removed.

pacificus is thicker than that in the series of *subauratus*, concealing the darker underfur more effectually.

Illustrative of modification in coloration within the same subspecies are the following observations on the coloration of base of tail. One specimen of *Castor s. subauratus* (no. 16383) has the coloration dorsally in this region paler than the rest of the series, approximately clay color. Ventrally the hairs are chestnut for nearly all their length. In another example (no. 8869) the hairs are pale in coloration both above and below, the colored ends being hazel instead of chestnut. In no. 12654, the type of *subauratus*, the hairs of this region are darker than the average of the rest of the series. Variation of about this amount is noted in all the subspecies of which adequate series are available. With all this modification, however, the series of ten skins of *subauratus* is remarkably uniform in general coloration.

The general aspect of the *subauratus* series is darker than that in *frondator*, the difference being due to darker underfur.

XVIII. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor s. subauratus	16385	298	124	41.6
Castor s. subauratus	16382	305	137	45.0
Castor s. subauratus	16383	311	133	42.8
Castor s. subauratus	8988	310	140	45.2
Castor s. subauratus	12654	320	139	43.4
Castor c. pacificus	126190	185	74	38.9
Castor c. frondator	20751	232	113	48.9

General cranial characters

Crania compared.—Castor subauratus subauratus, nos. 16383 ♂, 16384 ♂, 8988 ♀, and 12654 ♀, Mus. Vert. Zool., all from the vicinity of Grayson, San Joaquin River, Stanislaus County, California; *Castor canadensis pacificus*, nos. 3672, 71276 ♀, 71812 ♂, 71814 ♀, 87628 ♀, 87629 ♂, 126190 ♂, U. S. Nat. Mus., all from the mainland of Washington State; *Castor canadensis frondator*, nos. 60354 ♂, 3594 ♂, 35946 ♀, from the Colorado River, Mexico, 15 miles south of Yuma, Arizona, and from the San Pedro River, Mexico, respectively.

Comparable crania of *Castor s. subauratus* exhibit a tendency to be larger than those of *Castor c. pacificus*. They exceed those of *pacificus* absolutely in width of nasals and ratio of width of nasals to basilar length. Vertical diameter of foramen magnum less in all comparable crania of *subauratus* than in *pacificus* or in *frondator* with one exception (*pacificus* no. 71276 has this diameter 11.2, which is the same as that in *subauratus* no. 16383); and associated with this difference, the ratio of vertical diameter of foramen magnum to basilar length is less in the comparable crania of *subauratus* than it is in *pacificus* (with the single exception mentioned) or in *frondator*.

The anterior dilation of the nasal outline in *subauratus* is marked; it clearly separates the California form from *pacificus*, but not from *frondator*, though absolute measurements in *subauratus* exceed those in the latter.

In *subauratus* the extension of the nasals posteriorly of a line connecting the points of the antorbital processes is greater than in *pacificus*, but less than in *frondator* (actual measurements: *subauratus*, no. 16383, 1.0 mm.; 8988, 0.8. In *pacificus*, nasals pos-

XX. CRANI

FORNIA†

Museum number	Sex	Basilar length of Hensel		to basilar length	Ratio maxillary tooth-row to basilar length	Ratio vertical diameter of foramen magnum to basilar length
16384	♂	92.5	7(	.8	26.7	14.2
12668	♂	107.5	8(	0	22.2	12.1
8869	♂	109.7	8(	1	27.1	10.2
16385	♂	114.2	9:	9	26.9	9.9
16382	♀	112.4	9:	3	26.4	9.0
8987	♀	112.6	8(	5	26.7	9.4
12669	♀	116.0	94	2	26.7	10.5
4918	♂	116.2	98	7	25.7	9.6
16383	♂	120.1	96	2	26.5	9.3
8988	♀	119.8	94	5	26.0	8.3
12654	♀	126.3	103	3	27.3	8.0

*For manner of tak
paper.

†All from vicinity o
ined near Sespe,
Ventura County.

‡Length of fronto-m
of dividers into
Point of meeting of fro
adjust the other
Point of dividers at firs

XIX. COMPARISON OF CRANIAL CHARACTERS OF *Castor subauratus subauratus* TAYLOR, FROM THE SAN JOAQUIN VALLEY, CALIFORNIA, WITH *Castor canadensis pacificus* RHOADS, FROM WASHINGTON STATE, AND WITH *Castor canadensis frondator* MEARNS, FROM COLORADO AND SAN PEDRO RIVERS, MEXICO

Points of Comparison	*Castor subauratus subauratus* (nine examples)	*Castor canadensis pacificus* (seven examples)	*Castor canadensis frondator* (two examples)
Median constriction of interparietal	Not so much constricted on the average as in *pacificus*.	More constricted, on the average, than in *subauratus*.	Practically intermediate in degree of constriction.
Hamular processes of pterygoid bones	Thicker and heavier than in either subspecies.	Lighter than in *subauratus*.	Lighter than in *subauratus*.
Ventral contour of hamulars	Straightest.	Not so straight as in *subauratus*.	Not so straight as in *subauratus*.
Median process in interpterygoid fossa	Heavy and blunt.	Light and sharp (that of no. 71812 approaching a blunt condition).	Light and sharp.
Auditory bullae	Little inflated.	Comparatively much inflated.	Intermediate in condition between *subauratus* and *pacificus*, though nearer the latter.
Lateral ridge on auditory bullae	Strongly developed.	Weakly developed.	Intermediate in condition between *subauratus* and *pacificus*, though nearer the latter.
Paroccipital process	More prominent than in the other subspecies, extending more posteriorly, flattened instead of knob-like.	Not so prominent as in *subauratus*, extending more ventrally, less flattened, more knob-like.	Not so prominent as in *subauratus*, extending more ventrally, less flattened, more knob-like.
Relation of condylar foramina to occipital condyles	Condyles more pulled out posteriorly; foramina in plain view on basi-cranial aspect of skull in most specimens.	Intermediate in condition between *subauratus* and *frondator*.	Condyles more folded anteriorly; foramina not in plain view on basi-cranial aspect of skull, as in most examples of *subauratus*.

XVIII. Measurements and Ratios of Scaled Pc

All measurements in millimeters, and taken in dry sk

Subspecies—	Museum number	Length
Castor s. subauratus	16385	298
Castor s. subauratus	16382	305
Castor s. subauratus	16383	311
Castor s. subauratus	8988	310

but not from *frondator,* though absolute meas
tus exceed those in the latter.

In *subauratus* the extension of the nasals
connecting the points of the antorbital proces
pacificus, but less than in *frondator* (actual
auratus, no. 16383, 1.0 mm.; 8988, 0.8. In

XX. CRANIAL MEASUREMENTS* OF *Castor subauratus subauratus*, FROM WESTERN CALIFORNIA†
Specimens arranged approximately in order of age from top of table to bottom
(All measurements in millimeters)

Museum number	Sex	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Length of fronto-maxillary suture‡	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Greatest length of mandible; angle to anterior surface alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio vertical diameter of foramen magnum to basilar length
16384	♂	92.5	76.7	52.5	21.2	38.6	20.2	24.7	5.1	13.1	18.4	85.1	48.6	21.8	26.7	14.2
12668	♂	107.5	86.5	61.5	22.4	46.5	22.6	23.9	5.0	13.0	19.3	94.2	55.5	21.0	22.2	12.1
8869	♂	109.7	89.2	62.4	24.6	46.7	23.1	29.7	5.7	11.2	19.3	97.4	57.2	21.1	27.1	10.2
16385	♂	114.2	92.5	62.1	23.6	47.9	25.0	30.7	5.4	11.3	19.9	101.0	59.3	21.9	26.9	9.9
16382	♀	112.4	92.7	65.7	25.6	48.8	25.1	29.7	6.0	10.1	18.3	99.9	59.3	22.3	26.4	9.0
8987	♀	112.6	89.4	63.8	23.5	50.3	24.2	30.1	5.5	10.6	18.2	98.3	58.4	21.5	26.7	9.4
12669	♀	116.0	94.3	66.8	25.5	51.1	25.7	31.0	5.6	12.2	18.8	104.8	59.1	22.2	26.7	10.5
4918	♂	116.2	98.2	66.9	26.4	49.0	26.4	29.9	4.8	11.2	17.5	104.7	61.5	22.7	25.7	9.6
16383	♂	120.1	96.7	66.2	25.7	49.6	26.6	32.1	5.3	11.2	19.3	105.7	61.7	22.2	26.5	9.3
8988	♀	119.8	94.5	69.4	25.6	51.3	25.8	31.1	4.6	9.9	18.6	104.5	60.9	21.5	26.0	8.3
12654	♀	126.3	103.4	70.5	28.3	54.6	28.2	34.5	3.8	10.1	18.2	111.3	65.2	22.3	27.3	8.0

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of the present paper.

†All from vicinity of Grayson, Stanislaus County, except no. 4918, which is supposed to have been obtained near Sespe, Ventura County.

‡Length of fronto-maxillary suture: taken in region of anterior root of zygomatic arch; fit one point of dividers into point of meeting of frontal, premaxilla and maxilla; follow suture between maxilla and frontal laterad; adjust the other point of dividers at first point where maxilla touches jugal.

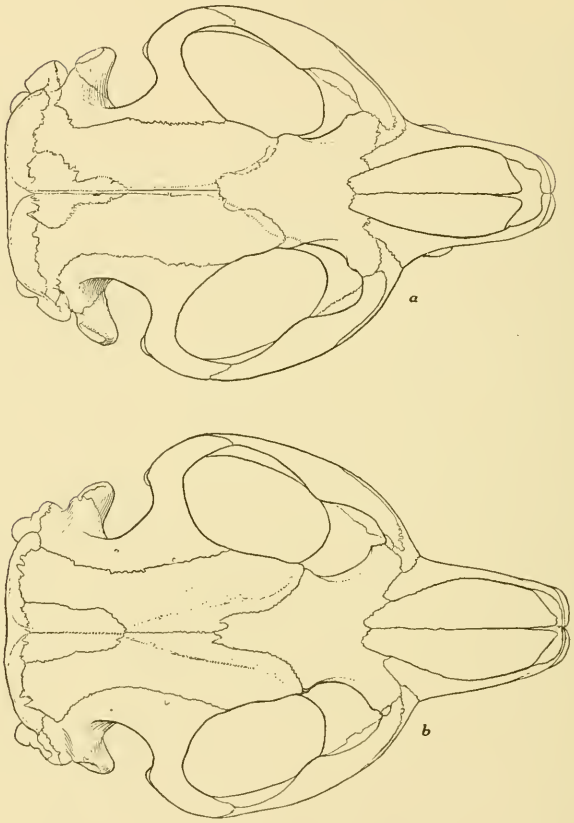

Fig. J. Dorsal view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus*. Note the different outline of the nasals and interparietal; the different conformation of the temporal ridges and the external auditory meatus; and the more massive character of the skull of the golden beaver. Approximately two-thirds natural size.

a. *Castor canadensis leucodonta*, no. 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

b. *Castor subauratus subauratus*, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

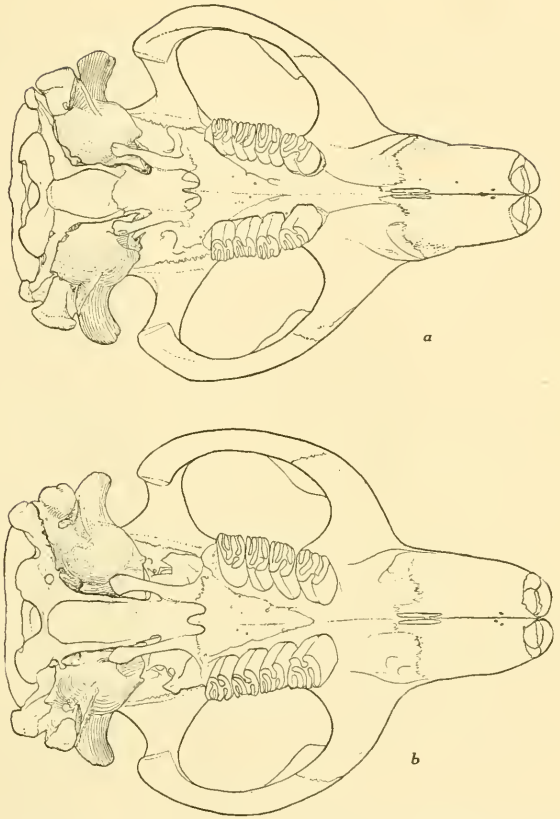

Fig. K. Ventral view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus*. Note the different breadth of rostrum; the difference in squareness anteriorly of the zygomata; the difference in hamulars and median process in the interpterygoid fossa; in the mastoids, the paroccipitals, the external auditory meatus, and the position of the occipital condyles. Approximately two-thirds natural size.

a. *Castor canadensis leucodonta*, no. 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

b. *Castor subauratus subauratus*, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

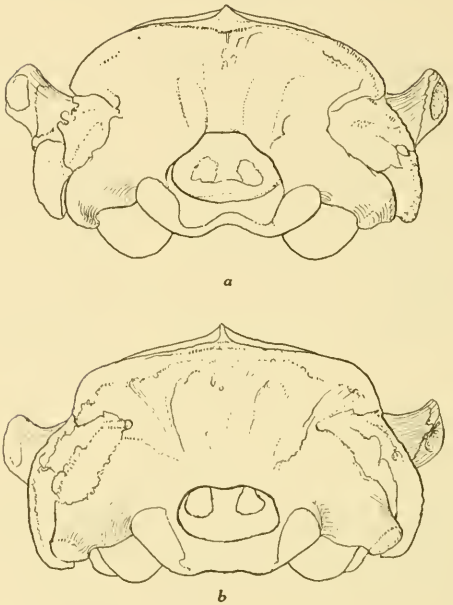

Fig. L. Posterior view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus.*[2] Note the different outline of the foramina magna; the difference in the external auditory meatus, and in general massiveness of crania. Approximately natural size.

a. Castor canadensis leucodonta, no. 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

b. Castor subauratus subauratus, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

teriorly approximate the line in some specimens, in others fail of doing so by several millimeters; *frondator*, no. 60354, 2.6 mm.; 35946, 3.3 mm.).

[2] In figs. J, K, and L comparison has been made between *Castor s. subauratus* and *Castor c. leucodonta* instead of *Castor c. pacificus*. For textual comparison of cranial characters of *leucodonta* and *pacificus* see pp. 442 to 446. They differ in nasal outline, breadth of hamular blades, and, as a rule, in the condition of occipital crest.

Rostra attain greatest breadth in *subauratus* (measured outside of swellings made laterally by ridge involving maxillary and premaxillary bones [see fig. M]; in *subauratus*, no. 16383, 34.8 mm.; 8988, 33.5; 12654, 37.8. In *pacificus*, no. 3672, 34.9 mm.; 71276, 33.6; 71812, 33.4; 71814, 31.7; 78395, 34.5; 87628, 32.7; 87629, 34.3. In *frondator*, no. 60354, 35.5 mm.; 35946, 30.2).

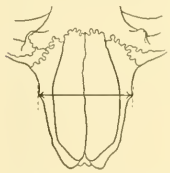

Fig. M. Dorsal view of rostrum, to show method of taking measurement. Approximately one-half natural size.

Hamular processes of pterygoid bones (see fig. F, p. 430) are broadest in *subauratus* (*subauratus*, no. 16383, 4.1 mm., 8988, 4.2, 12654, 4.3; *pacificus*, no. 3672, 2.1 mm., 71812, 2.5, 71814, 2.2, 78395, 3.4, 87628, 2.0, 87629, 2.8; *frondator*, no. 35946, 2.5 mm.). The two juvenals of *pacificus* from Fisher, Oregon, measure as follows: no. 136605, 4.3 mm.; no. 136606, 3.8. The young topotype cranium of *pacificus* from Keechelus Lake, Washington (no. 126190), has hamulars 4.3 mm. broad. The broader hamulars in the younger crania of *pacificus* would seem to indicate that this is a character which is different in individuals of different ages (see p. 444).

Mastoid process on the average is closest to auditory bulla in *subauratus* (see fig. N). Auditory bulla is of somewhat different shape in *subauratus* than in *pacificus* or *frondator*.

The following comments are in order respecting certain characteristics of *subauratus* as shown by the tables of measurements, p. 449 and opposite p. 438:

Fig. N. Ventral view of mastoid region, to show position of mastoid process relative to auditory bulla. About one-half natural size.

(1) The golden beaver is not, in most respects, on the basis of all the material, larger than the *canadensis* series of beavers. Most of the dimensions of no. 12654 of *subauratus* are greater than those of the largest skulls of any of the forms tabulated, however, except some of the individuals of its own subspecies *shastensis*, so that with complete material a size difference between *subauratus* and the *canadensis* series might be proved.

(2) Small vertical dimension of the foramen magnum would serve immediately to distinguish skulls of *subauratus* from those of any other western form of beaver, except in its own subspecies *shas-*

tensis, and in the following additional instances. Nos. 12668 and 16384, the youngest examples of *subauratus*, have foramina magna of larger dimensions than the older crania of that subspecies, and are not so characteristieally marked off from other species of beavers. Furthermore, no. 4232, from the Cook Inlet region, has as short a vertieal diameter of foramen magnum as has *subauratus*, as have also two very young specimens of *leucodonta* (nos. 12105, 12106), and one specimen of *pacificus* (no. 71276).

This measurement, the vertical diameter of the foramen magnum, is less, with the above exceptions, than in any other speeimen of beaver measured. The transverse diameter averages less than in *phaeus*, although it averages about the same as in *leucodonta*, *pacificus* and *belugae*, and greater than in *frondator* or *canadensis* from eastern Canada.

The ratio of the vertical diameter of the foramen magnum to the basilar length brings out concretely its different shape. This ratio is nearly forty-six percent (taken on the basis of comparison of averages derived from table X, opposite p. 438) greater in *leucodonta* and fifty-one per cent greater in *frondator* than it is in *subauratus*. It will be noted that the ratio decreases with age, the foramen magnum in the youngest example (no. 16384) being nearest to the *canadensis* series (see table XX, p. 449).

(3) The ratio of the width of nasals to basilar length is greater in every specimen of *subauratus*, and in four of the five speeimens of *shastensis*, than in any other subspecies of western beaver measured (except several specimens of *belugae*, and three examples of *leucodonta*).

(4) The ratio of the length of maxillary tooth-row to basilar length averages greater in comparable skulls of *subauratus* than in *pacificus*, its nearest neighbor on the north, but practically the same as in *frondator*, its nearest neighbor on the south.

CASTOR CANADENSIS FRONDATOR MEARNS, FROM THE COLORADO AND SAN PEDRO RIVERS, MEXICO

Material

Three specimens from United States National Museum: San Pedro River, Mexico, 1 (no. $\frac{3}{2}\frac{5}{0}\frac{0}{7}\frac{4}{5}\frac{6}{1}$, skin and skull); Lagoon of Colorado River, about 15 miles south of Yuma, Arizona, 2 (nos. 60354, 60355, skulls only).

COMPARISON WITH *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, *Castor canadensis pacificus* RHOADS, FROM WASHINGTON STATE, *Castor canadensis canadensis* KUHL, FROM EASTERN CANADA, AND *Castor canadensis belugae* TAYLOR, FROM COOK INLET REGION, ALASKA

General external characters

Specimens compared.—*Castor canadensis frondator,* no. 20751 ♀, U. S. Nat. Mus., from San Pedro River, Sonora, Mexico, October 14, 1892; *Castor c. leucodonta,* nos. 12101-12111, Mus. Vert. Zool., all but the last (which is from Great Central Lake) from Alberni, Vancouver Island, British Columbia, June 11 to August 25, 1910; *Castor c. canadensis,* no. 4358 ♂, U. S. Nat. Mus., Moose River, Ontario, Hudson Bay region, May 21, 1860; and nos. 174525 ♂, 174526 ♀, both U. S. Nat. Mus., Nepisiquit River, New Brunswick, September 25, 1911; *Castor c. belugae,* no. 4347 ♂, Mus. Vert. Zool., Snug Harbor, Alaska Peninsula, Cook Inlet region, June 14, 1904.

Since *leucodonta* is, in general, close to *pacificus,* and since no material of *pacificus* representative of external characters and comparable with *frondator* is available, comparison has been made between *frondator* and *leucodonta.*

XXI. MEASUREMENTS AND RATIOS OF SCALED PORTIONS OF TAILS

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. frondator	20751	232	113	48.9
Castor c. leucodonta	12101	237	120	51.0
Castor c. leucodonta	12111	243	108	44.6
Castor c. leucodonta	12107	270	124	46.0
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	4358	223	92	41.1
Castor c. belugae	4347	245	115	47.0

In general, the pelage is not so heavy-weighted, either in *frondator* or in *leucodonta* as in *canadensis.* General coloration in *canadensis* dark; in *leucodonta* paler; in *frondator* lightest. *Frondator* has the most uniform coloration. The overhair laterally is, however, of a brighter tint than that mid-dorsally, the lightest area being the cheeks. The single skin of *belugae* is darker than *frondator,* but paler than the New Brunswick *canadensis.* In proportions of tail it is closer to *frondator* than are the examples of *canadensis.* Proportions of scaled portion of tail are not clearly separative as regards

frondator, leucodonta, and *belugae,* at least on the evidence here submitted, though *canadensis* would seem to be separated off by its narrow tail.

General cranial characters

Crania compared.—Castor canadensis frondator, nos. 60354 ♂, 35946 ♀, U. S. Nat. Mus., from the Colorado River, Mexico, 15 miles south of Yuma, Arizona, and from the San Pedro River, Mexico, respectively; *C. c. pacificus,* nos. 3672, 71276 ♀, 71812 ♂, 71814 ♀, 87628 ♀, 87629 ♂, 126190 ♂, U. S. Nat. Mus., all from the mainland of Washington State; *C. c. canadensis,* nos. 174525 ♂ and 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick; *C. c. belugae,* nos. 4347 ♂, 4225 ♂, 4224 ♂, Mus. Vert. Zool., Cook Inlet region, Alaska.

Nasals of different outline in *frondator* than in *pacificus.* Their lateral outlines converge more regularly in a posterior direction, there being no tendency to be parallel, as is the case in comparable skulls of *pacificus.* The ratio of width of nasals to length tends to be greater in *frondator* than in *pacificus,* though there is decided overlapping. Measurements of foramen magnum similar, though most specimens of *pacificus* have their foramina broader in proportion to vertical diameter than is the case in *frondator.* Teeth in one specimen of *frondator* flare more laterally than in any specimen of *pacificus* (see fig. I, p. 442, *frondator,* no. 60354, 34.3 mm., 35946, 30.9; *pacificus,* no. 3672, 33.1 mm., 71276, 31.3, 71812, 30.4, 71814, 34.1, 78395, 32.5, 87628, 32.6, 87629, 34.3). Ratio of maxillary tooth-row to basilar length greater in *frondator.* Tooth-row longer in *frondator* no. 60354 than in *pacificus* no. 71812. These specimens have basilar length identical. Tooth-row longer in *frondator* no. 35946, with basilar length of 111.7 mm., than in *pacificus* no. 71812, with basilar length of 118.7.

Median process in interpterygoid fossa longer and sharper in *frondator* than in *pacificus.*

These differences between *frondator* and *pacificus* are for the most part slight. The outline of nasals is the most dependable single separative character.

Measurements fail to separate *frondator* either from *canadensis* or the Cook Inlet race. Distance from the inion to dorsal outline of foramen magnum less in *frondator* than in *canadensis* from New Brunswick (*frondator,* no. 60354, 18.9 mm., 35946, 18.0; *canadensis,* no. 174525, 20.9 mm., 174526, 19.9). Ratio of maxillary tooth-row to basilar length slightly greater in *frondator* than in the New Bruns-

XXII. COMPARISON OF EXTERNAL CHARACTERS OF *Castor canadensis frondator* MEARNS, FROM THE SAN PEDRO RIVER, MEXICO, WITH *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA, AND WITH *Castor canadensis canadensis* KUHL, FROM EASTERN CANADA

Points of Comparison	*Castor canadensis frondator* (one example)	*Castor canadensis leucodonta* (six examples)	*Castor canadensis canadensis* (two examples)
General coloration	Lightest of the three.	Darker than in *frondator*.	Darker than in *leucodonta*.
Dorsal overhair	Varying about cinnamon.	Varying about cinnamon-buff; no. 12108 with liberal insprinkling of seal brown hairs.	Hairs a mixture of blackish and ochraceous-tawny (nos. 174525, 174526, former the darker); general effect near chocolate or bay.
Dorsal underfur	Paler tints of the drab series than are found in either *leucodonta* or *canadensis*, near cinnamon-drab, light cinnamon-drab, and light drab.	Darker than in *frondator*. Varying from fuscous and fuscous-black to benzo and hair brown.	Near clove brown (nos. 174525, 174526).
Forefeet	Mixture of colors which in combination approach clay color and hazel.	Light brownish drab to near russet or mars brown.	General impression pale brownish drab (no. 174525); approaching warm blackish brown (no. 174526).
Hind feet	Mixture of colors which approach clay color and chestnut-brown; the chestnut-brown more in evidence making foot appear darker.	Paler brown than in *canadensis*, varying from near carob brown to near hazel.	Near dark vinaceous-drab (no. 174525); similar but with tendency to be lighter (no. 174526).
Ventral overhair	Close to cinnamon-buff.	Varying about hair brown.	Bone brown, dark grayish brown, or dusky drab (no. 174525); a trifle paler, near dark vinaceous-drab or natal brown (no. 174526).
Ventral underfur	Paler than *frondator*, approaching pale ecru-drab and pale drab-gray.	Darker than in *frondator*, approaching light drab and light cinnamon-drab.	Shaft of hair pale, nearest pale gull gray, tipped with drab-gray (nos. 174525, 174526).
Throat band	Practically undifferentiated, absent, though the overhairs on throat and chin are paler than those posteriorly, being colored near pinkish buff.	Inconspicuous; the few hairs present vary about warm buff.	Definite throat band present, the scattered paler hairs being near cinnamon-buff (no. 174525); nearer ochraceous-buff (no. 174526).
Base of tail above	A fringe of hairs at immediate base of tail colored near hazel and chestnut-brown.	Varies from near hair brown (no. 12111) to a shade between chocolate and bay (no. 12107); fringe of hairs near dark vinaceous-drab in several specimens (notably nos. 12108, 12101, 12102).	Cinnamon-drab to verona brown, hairs at immediate base of tail tipped with seal brown (no. 174525); chestnut to bay, hairs at immediate base of tail tipped with seal brown (no. 174526).
Base of tail beneath	Broad area at immediate base of tail near hazel and chestnut-brown in coloration.	Between cinnamon-brown and chestnut or bay.	Mixture of chestnut and cinnamon-drab, approaching pinkish buff laterally and anteriorly (no. 174525); liver or carob brown approaching orange-cinnamon laterally and anteriorly (no. 174526).
Tail	Broader proportionally than the average of *leucodonta;* much broader than *canadensis*.	Broader proportionally than *canadensis*, narrower on the average than *frondator*.	Narrowest proportionally of the subspecies here compared.

wiek examples. Zygomata not quite so square anteriorly in *frondator* as in specimens of *belugae* from Cook Inlet. Also distance from dorsal outline of foramen magnum to inion less (see fig. G, p. 431; *frondator,* no. 35946, 18.0 mm., 60354, 18.9; *belugae,* no. 4347, 20.5 mm., 4225, 22.4, 4224, 22.7); teeth narrower on average (see table of measurements, p. 428).

Nasal outline, condition of median process in the interpterygoid fossa, and certain skull dimensions, show the affinities of *frondator* to be with *canadensis* rather than with either *subauratus* or *pacificus.*

Outline of the History of the Beavers

The Castoridae and Castoroididae are probably derived from that primitive Eocene rodent stock represented in the family Ischyromyidae. Matthew (1910, p. 67) has outlined their possible relationships to this family, postulating their descent from the North American *Paramys,* an ancient squirrel-like form which with its contemporary relatives was perhaps ancestral to most, possibly to all, the members of the great order Rodentia. It has so far been impossible definitely to work out whether *Plesiarctomys* from the French Upper Eocene is congeneric with *Paramys* or distinct from the American genus.

According to Matthew's scheme, *Paramys* gave rise to *Sciuravus* of the North American Eocene, which in its turn is tentatively placed as the ancestor, on the one hand, of the stock which gave rise to *Eutypomys* of North American Middle Oligocene, and on the other, of that from which the important genus *Steneofiber* is derived. These two genera are the earliest which are referred by Osborn (1910, p. 535) to the Castoridae.

Concerning *Eutypomys* very little is known. Osborn refers to it as a ground-squirrel or semi-cursorial type, and suggests that it may be related to the Pteromyinae. It seems to be of little importance to the phylogeny of beavers. On the contrary, *Steneofiber* assumes a place of great importance in this phylogeny, being the supposed ancestor of most of the later genera belonging to the beaver family.

Steneofiber, which was about the size of a marmot, appears first in the Middle Oligocene (Stampian) of Europe, also throughout the Upper Oligocene of North America, being abundant and characteristic in the Upper John Day of Oregon. Evidently it became extinct soon after, for it has not been discovered in later deposits. At least by

Upper Oligocene, it should be remarked, *Steneofiber* had attained a world-wide distribution. It was replaced, in the Lower and Middle Miocene of Europe, by *Chalicomys*, which died out during the Pliocene. Matthew derived the phylogenetic side-line represented by *Hystricops* of the North American Miocene and Pliocene from *Steneofiber*.

Little is known concerning the genus *Euhapsis*, a supposed castorid genus which occurred in North America during Upper Oligocene.

Eucastor or *Dipoides* of Upper Miocene, as well as the genus *Castor* itself, which first appeared in that period, are probably also descended from *Steneofiber*. *Eucastor*, which was, like *Stenofiber*, about the size of a marmot, is first found in the North American *Hipparion* and *Procamelus* zones (Upper Miocene) and ranges into the Pliocene. *Sigmogomphius* (Merriam, J. C., 1896, p. 365) from the Pliocene near Berkeley, California, and *Dipoides*, from the Pliocene of Asia, are closely related to if not congeneric with it. Apparently the *Eucastor-Dipoides* stock appeared first in North America, spreading later into Eurasia. The *Eucastor* line soon ran out in the Old World, while in North America it appears to have given rise to the Pleistocene family *Castoroididae* with its characteristic genus *Castoroides*.

The earliest species of the European genus *Trogontherium* appeared in the Upper Pliocene, being there represented by teeth much smaller than those of its successor in the Pleistocene, *Trogontherium cuvieri*, the giant beaver of Europe, which was about one-fifth larger than the beaver of modern times. This genus coexisted in Europe with *Castor*, but died out at the close of what Osborn calls the First Faunal Subzone of the Second Pleistocene Fauna.

The largest species of the Pleistocene *Castorides* of North America attained the size of a black bear, and was, like the big European *Trogontherium*, preceded by a smaller form.

The genus *Castor*, on the basis of evidence now at hand, appeared somewhat earlier in Europe than in America. The Pontian Upper Miocene deposits are the first in Europe in which *Castor* has been discovered. The recent discovery (Kellogg, 1911, p. 401) of a beaver-tooth in the Pliocene of California seems to indicate that it soon attained a distribution embracing both continents. *Castor* is found in Pliocene and Pleistocene European formations, and is widespread in North American Pleistocene. It is lacking from the Pliocene and

all earlier formations of the latter continent except for the one instance mentioned above, the correlation of the formation in which the tooth was found being still somewhat uncertain.

If there has not been independent origin of *Steneofiber, Eucastor-Dipoides,* and *Castor* itself on the Eurasian and North American continents, it is clear that there have been several intercontinental migrations of beavers. Although we are not able to state exactly the number of these migrations, the evidence indicates that there were at least three.

While it is realized that negative evidence is likely to prove untrustworthy, and that possible errors in correlation introduce a further element of uncertainty into general statements as to the origin and migration of the castorids, insofar at least as these are based on relative time of appearance, it is believed that the following tentative propositions merit consideration.

Steneofiber probably developed first in the Old World, since it is found in Europe in Middle Oligocene while it does not appear in North America until the Upper Oligocene. By late Oligocene time, therefore, its migration had apparently carried it into North America.

The fact that the John Day epoch of the Oligocene is marked by the disappearance of almost all the European migrants which are so characteristic of the earlier White River fauna, with other evidence, has seemed to show that the land connection with the Old World was broken (Scott, 1913, p. 116). The case of *Steneofiber* might be taken to indicate, though such an isolated instance is probably not worth much, that the White River land connection was maintained into the early part of the John Day phase of the Upper Oligocene. It is more probable that *Steneofiber* crossed the connecting land bridge during White River time, but did not attain a widespread distribution until the John Day epoch.

The *Eucastor-Dipoides* stock would seem to have taken origin in North America, since it is first found in the Upper Miocene of that continent. By Pliocene time it had migrated at least into Asia. It seems certain that Bering Strait was closed during at least a great part of that epoch (Scott, 1913, p. 125).

The genus *Castor* probably arose in Eurasia from *Steneofiber* or a closely related stock. A wave of migration carried it into North America during the Pliocene, probably by way of the North-Pacific land-connection, and its remains became widely distributed and fairly abundant in the Pleistocene.

Summary of Relationships of Certain North American Beavers

SOME DIFFICULTIES TO PRECISE STATEMENT OF RELATIONSHIP

Gregory (1910, p. 105) has called attention to the stumbling-blocks of the phylogenist, namely the two difficulties, first, of distinguishing between primitive and specialized characters, and second, between resemblances significant of genetic relationship and those indicating only convergence or parallelism.

That parallelism in evolution may be a principle more widespread and of greater significance than is ordinarily accorded it by taxonomists has recently been suggested (see Scott, 1913, pp. 649-656, and Hopkins, 1914, p. 187). It should be clearly recognized, however, that the weight of evidence indicates (Scott, 1913, p. 137) that independent origin of closely similar forms from different stocks in widely separated localities is practically unknown.

Emphasis should also be laid on the importance: (1) of determination of the order of appearance of diagnostic characters; and (2) of understanding the general adaptive significance of such characters, so that their broader phylogenetic and systematic value can be appraised (Gregory, 1910, p. 112). We are not now in position to prove in what order the diagnostic characters in the family here considered have appeared, or to state exactly the adaptive significance or insignificance of the characters. The fact that it is difficult to ascribe any adaptive value whatever to many of the characters which are diagnostic between subspecies and species of beavers does, however, suggest that these particular characters may be dependable as indicating relationship. Examples of such characters are: Different outlines of tail; different outlines of nasal bones; different degrees of development of median process of interpterygoid fossa; different shapes of foramen magnum; different breadths of hamular processes of pterygoids; different widths of bony palate anteriorly.

There are possible further difficulties. Since we do not certainly know that the evolution of one form has not taken place somewhat more rapidly than that of another, estimates of time of isolation (or age of a particular form) and closeness of relationship should only cautiously be based on degrees of difference.

CONSIDERATION OF CERTAIN NORTH AMERICAN FORMS

Certain problems remain to be considered regarding the relation-

ships of beavers, some of these being: (1) the relation of the beaver of North America to that of Europe and Asia, and (2) the interrelations of the North American forms. Under the second head arises the question whether groupings of the North American forms are possible, and since groupings *are* possible, further problems arise as to their interrelationships, their ancestry, and the causes and conditions in their differentiation.

The relationships of the American and Eurasian beavers have been more or less fully discussed by the following authors: Geo. Cuvier (1817, tome 1, p. 191, not seen; and 1825, tome 5, p. 57, not seen); Fred. Cuvier (1825, liv. 51, not seen); Brandt and Ratzeburg (1827, pp. 12-30); Brandt (1855, pp. 43-66); Morgan (1868, pp. 42-45); Ely (*in* Morgan, 1868, pp. 288-306); and Allen (1877, pp. 437-445). While sufficient material to justify a review of this point has not been available, the present writer has been able to compare three skulls of *Castor fiber* from the Elbe River, Germany, with the American beavers, and believes that the evidence indicates that they are specifically distinct.

Several points of possible significance arise in connection with the problem of the interrelationships of the North American beavers. Material illustrative of two species of Nearctic beavers, as well as of all their subspecies but two (*Castor canadensis carolinensis* Rhoads and *Castor canadensis mexicanus* Bailey), has been available in this study. Even a cursory examination of this material shows that all those beavers listed under *canadensis*, namely subspecies *canadensis, michiganensis, belugae, leucodonta, pacificus, frondator* and *texensis*, fall into one group, while those listed under *subauratus*, namely subspecies *subauratus* and *shastensis*, fall into another. Within these groups the subspecies appear to be closely related, their differentiation apparently having progressed to a slight extent only. From their geographical situation and from a consideration of such of their characters as may be worked out from the literature, species *caecator* Bangs and subspecies *mexicanus* Bailey and *carolinensis* Rhoads should be referred to the *canadensis* group.

The members of the *canadensis* group are, on the basis of available material, unequally related. For example, *Castor canadensis phaeus*, from Admiralty Island, Alaska, is less closely related to *Castor c. canadensis* of eastern Canada than is *Castor c. belugae* of the opposing mainland. *Phaeus* is more sharply marked off from the other subspecies of *canadensis* than are *Castor c. frondator* or *belugae*. *Phaeus*

cannot be said, on grounds of compared characteristics, to be closer to *belugae* than it is to eastern *canadensis*. *Belugae* is more closely allied to *canadensis* of eastern Canada than is either *Castor c. leucodonta* or *Castor c. pacificus*. It is impossible to decide to which of the two mainland subspecies (*belugae* or *pacificus*) *leucodonta* is most closely related. *Frondator* is more closely allied to *canadensis* of eastern Canada than it is to the California species of beavers or to the *belugae-leucodonta-pacificus* series. *Castor c. michiganensis* finds its closest relative in *canadensis*.

The California beavers stand by themselves, having undergone considerably more divergence than the other subspecies, and their immediate ancestry is decidedly uncertain. Mr. F. H. Holden, of the staff of the Museum of Vertebrate Zoology of the University of California, who has carefully compared such skeletons of beavers as are available, has called the writer's attention to the fact that the majority of skeletal characters of *Castor subauratus subauratus* would relate it rather to the Eurasiatic *Castor fiber* than to the North American *Castor canadensis*. This testimony, however, is not borne out by the skull characteristics, which would seem definitely to relate *subauratus* to the *canadensis* series. Perhaps the most striking differences between the *subauratus* series and the *canadensis* series are the different shapes of the foramen magnum and of the median process in the interpterygoid fossa. *Castor c. pacificus* and *Castor c. belugae* are somewhat more variable respecting these characters than are any other subspecies of *canadensis*, and individual skulls of these show a more decided bent in the direction of *subauratus* than do the other forms, which suggests the possibility that *subauratus* has been derived from the form which was ancestral also to the subspecies occupying the mainland of Oregon, Washington, British Columbia and Alaska. If this should be the case, the relationship of the California forms with *canadensis* would be close, and the comparatively large amount of divergence would be noteworthy as possibly indicating a more rapid evolution, or a more complete isolation from the parent stock (possibly both together) than is exemplified by the other forms.

Remarks on Isolation and Its Relation to Speciation

Consideration of Some of the Evidence

Evidence from the Study of Beavers

We may now profitably undertake a review of some of the facts

of beaver distribution, with special reference to the problem of speciation in the group.

It should be remembered that the beavers of Eurasia and America, while not distantly related, are still very clearly marked off specifically. It should further be called to mind that there are, on the North American continent, two distinct groups of beavers, the *canadensis* group, including the species *canadensis* with at least its subspecies *canadensis, belugae, leucodonta, pacificus, frondator* and *texensis*, and the *subauratus* group, including the species *subauratus* with its subspecies *subauratus* and *shastensis*.

In the case of each one of these subspecies of beavers, geographic range seems to be as characteristic as any physical attribute. It should be emphasized that differentiation in beavers has progressed only to a slight degree as compared with, for example, the Geomyidae, and that all the forms of beavers, even the two groups, are relatively closely related. No case of overlapping of subspecific or specific ranges is known. Knowledge of the details of the relations of distribution of beavers to topography is not sufficient to warrant categorical assertions without some qualification, but available evidence points to the truth of the following general statements.

Castor c. michiganensis, a small, dark form, is very closely related to *C. c. canadensis*, its neighbor on the north. The type locality of *canadensis* is Hudson Bay, and the subspecies probably ranges south to the chain of Great Lakes, which would seem to be a barrier separating it from *michiganensis*.

The type locality of *Castor c. canadensis* (Hudson Bay) is connected by a nearly continuous series of streams and lakes with extreme western Canada. Distance is practically the only deterrence to the migration of individuals from eastern Canada to the base of the Canadian Rockies and the Alaskan Mountains. Subspecies *belugae*, of *canadensis*, occupying the Pacific territory from Cook Inlet to British Columbia, is closely related to *canadensis* on the one hand and to *leucodonta* and *pacificus* on the other. Subspecies *phaeus* of Admiralty Island, southeastern Alaska, is comparatively sharply marked off. *Frondator*, type locality San Pedro River, Mexico, which is supposed to range some distance to the north, is also closely related to *canadensis*. On the other hand, *subauratus* and its subspecies *shastensis* are much less closely related to *canadensis* than any of the other forms, and there do occur, bounding the range of the *subauratus* group, masses of high mountains on the north, east and south, as

well as broad deserts on the east and south. The two subspecies of *subauratus,* namely *subauratus* and *shastensis,* are much more closely related to each other than is either to any other known beaver in the world. Although they are inhabitants of the same hydrographic basin, they are efficiently separated by distance in combination with the "narrows", by way of which the Pit River cuts through the Sierra Nevada Mountains.

It must be immediately apparent that these facts, so far as they go, fulfill the requirements of Wagner and Jordan's law: "Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort."

It is now quite well established that on continuous land areas temperature is the most efficient of all barriers, with humidity of the atmosphere a close second. It is a remarkable fact that the genus *Castor* ranges, undergoing at the same time but little change, through all the life-zones (based on temperature) from the Hudsonian of the northern limit of trees to the Lower Sonoran of the southern deserts, and that it is found in faunal areas (based on humidity) as widely different as the Sitkan district of southeastern Alaska and the Colorado Desert of the southwestern United States. Although the semi-aquatic environment of the beaver is doubtless more uniform throughout this great range of temperature and moisture conditions than is the typical terrestrial environment, it must still be conceded that the genus *Castor* is subjected to very different environments in different parts of its range. The writer at this moment finds it impossible to assign any adaptive significance to the subspecific and specific differentiatory cranial characters of beavers. It must be confessed that the maintenance by the beaver of its chief characteristics through a very wide range of environmental conditions, coupled with the further fact that it is difficult to attribute any adaptive significance to the cranial specific and subspecific characters, invite one to the hypothesis that these characteristics of the different races of beaver are due to a cumulation of what are for the most part inutile characters through the fact of the geographical isolation, alone, of the various beaver stocks.

An alternative view is, of course, that our inability to see the adaptive significance of these differentiatory characters, or definitely to correlate them with characters which are obviously adaptive, merely testifies to the limitations of our own knowledge, and not at all that

these characters are really not adaptive or not correlated with some adaptation. However this may be, it would seem that the possibility that geographical isolation alone, with no assistance from natural selection, has been a condition in speciation of beavers, is by no means excluded.

Evidence from Certain Other Families of Mammals

Its great geographical extent and wide diversity of topographical and environmental conditions make California probably as favorable a geographic unit as could be found for the study of problems concerning the origin and maintenance of vertebrate species; and since the writer is more familiar with the mammalian fauna of California than with that of any other area, this particular field has furnished most of the material used. But published facts from mammalian distribution in the Great West, and in the continent generally, have been freely drawn upon.

In cases where the family or genus has recently been monographed, relationships as outlined may be regarded as more dependable than in those instances in which the group has not undergone adequate revision. In the latter the conclusions reached are tentative, and are based upon the writer's familiarity with the mammalian fauna in question.

Soricidae

Sorex vagrans vagrans, the range of which within California (Grinnell, 1913*a*, p. 270) includes the Upper Sonoran, Transition and Boreal zones in the western portion of the state, east to Shasta County and south as far as Monterey, finds in *Sorex vagrans amoenus* its nearest relative within the state. The range of the latter form takes in the Transition and Boreal zones of the Sierra Nevada Mountains, at least from Mono County north to Mount Shasta (Merriam, C. H., 1895, p. 68, and 1899, p. 87). *Sorex halicoetes*, of the salt marshes bordering the south arm of San Francisco Bay, is more closely allied to *Sorex vagrans vagrans* than it is to any other species of *Sorex* (Grinnell, 1913*a*, p. 184). It will be remembered that *Sorex vagrans vagrans* is found coastwise in California as far south as Monterey.

Sorex sinuosus of the brackish marshes of Grizzly Island, Suisun Bay, California, is most closely related to *Sorex californicus* of the neighboring uplands.

Note should be made of the distribution of the *tenellus* group of

subspecies. *Sorex tenellus tenellus* occurs on the Alabama Hills, near Lone Pine, Inyo County, California. *Sorex tenellus lyelli* is a closely related form occurring on Mount Lyell in the Sierra Nevada, and *Sorex tenellus myops* is known only from the White Mountains of Inyo County, California, which lie to the eastward of Mount Lyell near the California boundary line. *Sorex tenellus nanus* is an outlying relative found in the Rocky Mountains of Colorado.

The widely distributed *Sorex montereyensis montereyensis*, which is found in the Transition and Upper Sonoran zones of the northern and central coast districts of California from the Oregon line to San Luis Obispo County, has as its nearest relative *Sorex montereyensis mariposae*, which is also broadly distributed, being a montane form found in the Transition zone of the Sierra Nevada and Warner Mountains, and in the inner coast ranges as far south as Lierly's Ranch, four miles south of Sanhedrin Mountain, Mendocino County.

Sorex obscurus obscurus occurs in the Transition and Boreal zones of the Sierra Nevada Mountains from Mono County north. This is a subspecies of very broad distribution, being found in southern British Columbia and northern Washington and in the Rocky Mountains, as well as in the Sierra Nevada (Merriam, 1895, p. 73). Its closest allies are *Sorex obscurus longicauda*, occupying a narrow strip along the Pacific coast from the mouth of the Columbia River to Wrangel, Alaska, and *Sorex obscurus ventralis*, inhabiting the mountains of Oaxaca, in southern Mexico.

Neosorex bendirii bendirii, occupying in California the Transition and Boreal zones of the humid northwest coast belt from Humboldt Bay to Gualala, is also found in the Klamath Basin, Oregon, and thence northward along the east side of the Cascade Range to Puget Sound (Merriam, 1895, p. 96). Its closest allies are *Neosorex bendirii palmeri*, of the coast of Oregon and the Willamette Valley, and *Neosorex bendirii albiventer*, from Lake Cushman, Washington.

This terminates the list of the California Soricidae, the relationships of which are best known. Concerning *Sorex shastensis* from Mount Shasta, *Sorex pacificus* from the north coast district of California, and the *Sorex ornatus* series from Mount Pinos and other mountains of southern California, our knowledge is indefinite.

Procyonidae

The Pacific raccoon, *Procyon psora pacifica*, type locality Keechelus Lake, Cascade Mountains, Kittitas County, Washington, ranges into

California on the north, occupying the Transition and Upper Sonoran zones along its northern border. The vicinity of Pit River, Shasta County, is its southern limit. Occupying both Lower and Upper Sonoran and Transition of the rest of the state except the southeastern deserts, is *Procyon psora psora*, the California raccoon, which is very closely related to its northern neighbor, and doubtless intergrades with it. Favorable situations in the southeastern desert region are inhabited by the pallid raccoon, *Procyon pallidus*, while a fourth California form has recently been described from the San Diegan region west of the Coast Range Mountains in extreme southwestern California (*Procyon psora californicus*, Mearns, 1914, p. 66).

MUSTELIDAE

The closest ally of *Martes caurina caurina*, the pine marten, the range of which includes the Transition and Boreal of northwestern California, is *Martes caurina origenes* which is found in the Boreal of the Rocky Mountains of Colorado (Cary, 1911, p. 189). *Martes pennanti pacifica*, the Pacific fisher, finds its closest living relative in *Martes pennanti pennanti* of eastern Canada. The Sierra Nevada and Mount McKinley wolverines, *Gulo luscus luteus* and *Gulo luscus hylaeus*, are closely related, and both are close to the *Gulo luscus luscus* of Canada.

Details of distribution and relationships of the weasels are hardly complete enough to be satisfactory. However, it is certain that the diminutive *Mustela muricus* of the Sierra Nevada is a member of the boreal *cicognanii* group of weasels. A close ally of *muricus* is resident on the Pine Forest Mountains of northern Nevada. An undescribed weasel most closely related to *Mustela streatori* of the Puget Sound district occurs on the north coast of California. The *Mustela arizonensis* is said (Merriam, 1896, p. 22) to be a mountain form of *Mustela longicauda* of the Great Plains from Kansas northward. *Mustela arizonensis* is found in the Transition and Boreal zones of the Sierra Nevada from Mount Shasta to Tulare County, as well as on the San Jacinto Mountains. Its distribution is stated as follows: "Broadly, the Sierra Nevada and Rocky mountain systems, reaching British Columbia in the Rocky Mountain region, but not known north of the Siskiyou Mountains in the Sierra-Cascade system". North of the Siskiyou Mountains in the Sierra-Cascade system occurs its close relative, *Mustela saturata*. The relationships of *arizonensis* are not clear, since Merriam states (*op. cit.*, p. 23) that Sierra specimens

show a strong tendency to grade into *xanthogenys,* the form of the California lowlands.

The closest relatives of *Mustela xanthogenys xanthogenys* of California west of the desert divides, from the Mexican line north through the San Diegan district, and in west-central California east of northern humid coast belt, at least to the head of the Sacramento Valley, are *Mustela xanthogenys munda* (doubtfully recognizable), of the humid coast Transition north of San Francisco Bay, and *Mustela xanthogenys oregonensis,* of Rogue River Valley, Oregon.

The Pacific Mink, *Mustela vison energumenos,* is most closely related to its neighbors, *Mustela vison nesolestes,* of the Alexander Archipelago, Alaska, and *Mustela vison lacustris* of the interior of Canada and the northern United States (Hollister, 1913, p. 476).

Turning to the genus *Spilogale,* it is noted that two closely related forms invade eastern California but do not cross the Sierra Nevada. These are *Spilogale gracilis saxatilis,* found in the northeastern corner of the state, and *Spilogale gracilis gracilis,* inhabiting the Sonoran zones of the Inyo region. *Spilogale arizonae arizonae* of the lower Colorado River region is most closely allied to *Spilogale arizonae martirensis* of Lower California. *Spilogale phenax phenax,* inhabiting most of the Pacific slope of California, is apparently replaced by *Spilogale phenax latifrons* in the coast region of extreme northern California and Oregon. Another race of the species *phenax, Spilogale phenax olympica,* is found on the Olympic Peninsula and the shores of Puget Sound (Miller, 1912, p. 106).

The genus *Mephitis* is represented by five forms within California, three of these belonging to the species *occidentalis.* This species is represented in western North America by five races (Howell, 1901, pp. 34-38). *Mephitis occidentalis occidentalis* is found in northern and central California, west of the Sierra-Cascade system, from Monterey Bay to the Willamette Valley, Oregon. The coast region of Washington and northern Oregon, as well as the shores of Puget Sound, are occupied by *Mephitis occidentalis spissigrada.* In the eastern part of southern Washington and northern Oregon, on the desert side of the Cascade Mountains, is found *Mephitis occidentalis notata,* which intergrades with *occidentalis* and *major. Mephitis occidentalis major* is found in eastern Oregon, northeastern California and Nevada, ranging east to the Wasatch range in Utah. Its closest relatives are *notata* and *occidentalis,* its neighbors on the north and west respectively. In southern California the group is represented by

Mephitis occidentalis holzneri. The case of *Mephitis platyrhina* from the south fork of the Kern River and Owens Valley, California, is of interest and possible significance. Its range (Howell, *op. cit.*, p. 39) is overlapped by that of *Mephitis occidentalis holzneri*. If Howell's suggestion that *platyrhina* may intergrade with *major* be true, then the latter, occupying territory to the north, is the closest relative of *platyrhina*.

One other *Mephitis*, namely *Mephitis estor*, is found in California. This is probably an invader from the east, its geographic distribution including Arizona, western New Mexico, Sonora, Chihuahua, and northern Lower California, as well as the valley of the lower Colorado River in California. Although *Mephitis estor* is a very distinct species, its closest relative would seem to be *Mephitis mesomelas varians*, whose range lies to the east. Howell (1901, p. 33) goes so far as to suggest that it is possible that intergradation takes place between the two.

The California badger, *Taxidea taxus neglecta*, unquestionably intergrades with and is most closely related to *Taxidea taxus taxus* of eastern America. Specimens of badgers from the Pine Forest Mountain region of northern Nevada have been referred to the latter (Taylor, 1911, pp. 296, 297). In the arid southwestern United States and northern Mexico is found the Mexican badger, *Taxidea taxus berlandieri*. The fourth form is *Taxidea taxus infusca*, found in Lower California.

The aquatic genus *Latax*, which occurs off the west coast of America and the northeast coast of Asia, finds in the terrestrial and fluviatile genus *Lutra*, which is found both in Asia and North America, its closest living relative (Taylor, 1914, pp. 493, 495).

Muridae

The Muridae are represented in California by so large a number of groups and species that details may justifiably be omitted. This great family must not be passed over, however, without calling attention to the interesting data presented by the *Peromyscus maniculatus* series of mice. This group is represented by forty-three subspecies or small species distributed nearly throughout the North American continent.

This was the first to be named and almost the last to be recognized of a large group of inosculating forms—the largest and most remarkable of the genus and perhaps of American mammals. Its distribution is wider and the

number of intergrading forms and of individuals is greater than in any similar group of mammals known. From typical *maniculatus*, development may be traced step by step absolutely without break through all the numerous subspecies (Osgood, 1909, p. 41, and frontispiece).

Here we have a spectacular illustration of the principle that the closest relative of any form is found, not in a locality far distant nor in a locality identical with that occupied by the form, but in a neighboring region separated from the first by a barrier of some sort (see p. 464).

Respecting the Californian forms of the genus *Onychomys* it may with all assurance be said that no two species are found in one locality. This genus has recently been revised by Hollister (1914, pp. 427–489).

The distribution of the Murid genera *Reithrodontomys, Sigmodon, Neotoma, Evotomys, Microtus,* and *Fiber,* as well as of the genus *Peromyscus,* afford a mass of material similar to that which has already been adduced.

Zapodidae

Zapus trinotatus trinotatus ranges from the coast region of southern British Columbia, Washington (including Cascades), Oregon (west of western base of Cascades), to northern California, being found as far south as Carson's Camp on Mad River, Humboldt County. Its closely related subspecies *Zapus trinotatus alleni* (Preble, 1899, pp. 27, 28) occupies the Boreal zone of the Siskiyou, Trinity, and Sierra Nevada mountains, as well as the inner coast range as far south as South Yolla Bolly Mountain (between Tehama and Trinity counties).

Zapus major is probably an outlying form with *trinotatus* affinities (Preble, 1899, p. 25). It is found on the Warner Mountains of Oregon and California. *Zapus orarius* is found in the humid coast belt of California from Marin County to Humboldt Bay. Its relationships are not clear, but it is probably nearest to *Zapus pacificus,* which is found in the interior valleys of southwestern Oregon and northwestern California.

Aplodontiidae

Although detailed facts regarding the aplodontias are not so numerous as is desirable, it seems obvious that the relationships of the California forms are as follows: The recently described *Aplodontia chrysaola* (Kellogg, 1914, pp. 295, 296) occupying the Trinity and

Siskiyou mountains is most closely allied to *Aplodontia californica* of the Sierra Nevada Mountains. On the other hand, the coast forms, *Aplodontia pacifica*, found at Newport, mouth of Yaquina Bay, Lincoln County, Oregon, *Aplodontia nigra*, Point Arena, Mendocino County, California, and *Aplodontia phaca*, Marin County, California, would seem to be most closely related among themselves.

Ochotonidae

This small but interesting family is found only upon or near the summits of the highest mountains in California. Three species are represented within the state, *Ochotona taylori*, of the high peaks of the Warner Mountains of northeastern California; *Ochotona schisticeps*, of the central and northern Sierra Nevada; and *Ochotona albatus*, of the Mount Whitney region, southern Sierra Nevada. It is not improbable that *Ochotona taylori* is more closely related to *Ochotona schisticeps* of the region intervening than it is to *Ochotona albatus* of the Mount Whitney region of the southern Sierra.

Cervidae

Odocoilcus columbianus columbianus occupies the northwest coast region of California and northward at least to the Columbia River. It is found as far to the eastward in California as Mount Shasta and extends through the inner coast mountains to the Sacramento Valley. The Golden Gate, San Francisco Bay, separates it from the closely related *Odocoilcus columbianus scaphiotus*, which is found in the Transition and Upper Sonoran zones southward through the Santa Cruz district into Monterey and San Benito counties.

Characteristic of the Sierra Nevada and the southern and desert ranges within the state is the mule deer. *Odocoilcus hemionus hemionus* is found to be generally distributed in eastern California, from the southern end of the High Sierra north to the northeastern corner of the state. It comes in contact with *Odocoilcus columbianus columbianus* in the Shasta region, where there may be some overlapping of range. From the Tehachapi Mountains (southern end of high Sierra Nevada) westward through the Tejon region to the coast mountains and southward to the Mexican line, west of the desert proper, occurs *Odocoilcus hemionus californicus*. There formerly occurred on the deserts of southeastern California the burro deer, *Odocoileus hemionus eremicus*, but the subspecies seems now to be extinct north of the Mexican line. These forms of the mule deer are very closely related, and it is evident that they occupy adjoining ranges.

Summarization

Having now adduced evidence from a study of nine families of mammals, representative of four orders, we may profitably undertake to discover whither it leads us.

Before proceeding it ought to be stated that this evidence is typical of that which would be gathered in course of the consideration of any family whatever of California mammals. The evidence might be greatly extended, but such extension would imply much unjustified repetition, for further evidence would probably not illustrate the actual state of things any better than that which we now have at hand.

It should be remembered that our present concern is the gathering, so far as that may be here practicable, of the evidence on the differentiation of species, or polytypic evolution (the splitting up of a parent stock into a number of differentiated stocks), as opposed to monotypic evolution (continuous change through time and in a given direction of the entire stock without divarication). Thus we are not discussing the problem of the mode of organic evolution primarily, except in so far as this problem is bound up with considerations of differentiation.

Furthermore, we propose to discuss this matter from the standpoint of studies, first of mammals, and second, of the higher vertebrates in general. It is hardly to be assumed that the same conditions and factors of organic evolution apply universally, or that, where they do apply, they must act in exactly the same way.

An illustration of the heterogeneity of the organic world is fortunately furnished by the very problem with which we are here dealing, namely, that of the place of geographic isolation in specific differentiation. We are indebted to Kofoid (1907*a*, pp. 500-506) for calling pointed attention to the possible limitations of isolation in the origin of species. After remarking the high degree of cosmopolitanism of the fresh-water microfauna and flora, Kofoid emphasizes the fact that there is not only extensive coincident distribution of related species, but that there are numerous cases in which there is actual coexistence of the most closely related species in the same habitat.

Similar evidence is adduced by Clark (1911, p. 23), who demonstrates the coincident distribution of closely related species among the Ophiurans. There seems to be abundant evidence that very closely related species of this group, often the most closely related,

inhabit the same area, and that "Jordan's law" does not apply to this class of Echinoderms; and further, that "physiological isolation" in some form has been a more important factor than geographical or bathymetrical isolation in the specific differentiation of Ophiurans. This state of things stands, of course, in strong contrast with the widespread isolation of related species and subspecies in birds, mammals, and vertebrates generally (see p. 475).

RELATION OF EVIDENCE TO SOME CURRENT THEORIES

Do the facts of distribution which we have before us meet the requirements of Darwin's hypothesis as to the origin of species

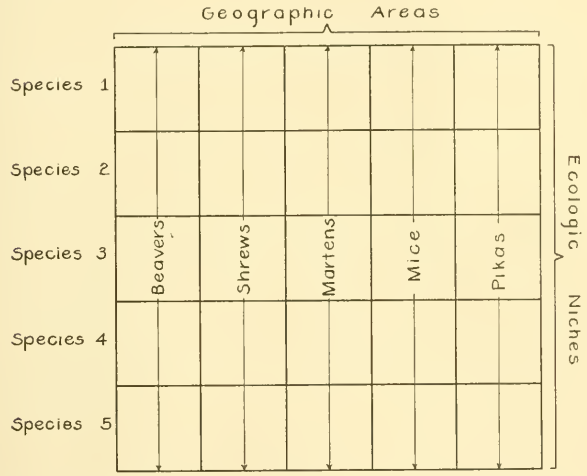

Fig. 0. Diagram illustrative of species arrangement as we ought to find it in nature according to Darwin's theory of differentiation in the same place through the advantage of divergence.

through natural selection in the same place through the advantage of divergence? Do they accord with De Vries' theory of mutations, according to which the parent species, after passing into a mutation period, gives rise to one or more elementary species or retrograde varieties, which may coexist with the parent stock in the same locality? Do they fulfill demands of Romanes' and Gulick's physiological selec-

tion according to which there may be segregation of sections of the same species in the same place, and so divergent evolution, through preferential mating?

It will be apparent immediately that the facts here adduced do not harmonize with the requirements of any of the hypotheses above mentioned; for on any one of them we ought, at least occasionally, to find species arranged in nature as illustrated in the accompanying diagram (fig. O). According to this diagram each group is represented to have undergone divergence in the same place, until its members occupy different ecologic niches, the horizontal lines representing physiological, the heavy vertical lines geographical, barriers. What we do find in nature is that species are arranged quite otherwise (fig. P).

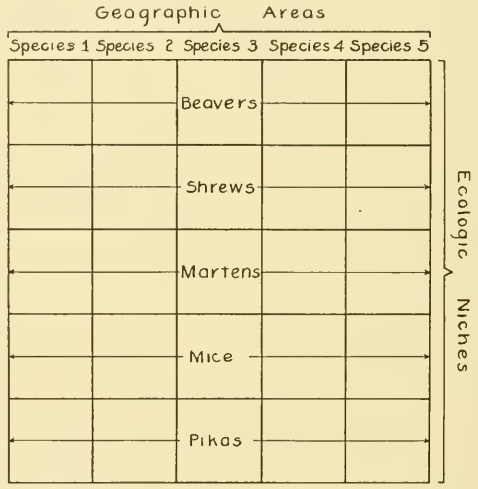

Fig. P. Diagram illustrative of species arrangement as we actually do find it in nature.

Each group, speaking now in general terms, for there are some exceptions, occupies the same ecologic niche in different places, rather than different ecologic niches in the same place. The two propositions are theoretically well balanced, and on *a priori* grounds one would perhaps be unable to discover any argument in favor of the one arrange-

ment as over against the other. But the facts of geographical distribution of higher vertebrates point unequivocally to figure P as a more accurate illustration of species arrangement than is figure O.

Relation of Evidence to Wagner's Theory of Migration and Geographical Isolation

There is left Wagner's theory, that the differentiation of species has taken place through migration and geographical isolation, the migration and spatial isolation being, according to this view, the conditions without which specific differentiation does not take place. With this proposition the evidence from mammals and higher vertebrates in general seems to be, for the most part, in complete harmony. The terms of this theory demand that a group made up of closely related forms be represented by one species or subspecies, only, in each locality, and that the most closely related forms be separated by some barrier which shall keep them from interbreeding to an extent that would bring about the swamping of incipient characters. In other words, on this theory, groups of related species should be arranged as illustrated in figure P. And so they are.

Reference has already been made (p. 472) to Kofoid's suggestion regarding the coincident distribution of some of the most closely related species of the fresh-water microfauna and flora. In another paper (1907*b*, pp. 241-251) the same author considers the distribution of the Chaetognatha with reference to its bearing on the relation of isolation to the origin and preservation of species, coming to the following conclusion: "The apparently wide-spread phenomenon of coincident distribution of related species among pelagic organisms appears to east some doubt upon the universality of the operation of isolation in the evolution of species as originally maintained by Moritz Wagner (1868) and recently revived by President Jordan (1905)." In the course of this paper Kofoid emphasizes the lack of specific distributional data, especially of that pertaining to vertical distribution.

Supplementary in a way to this work of Kofoid is an exceedingly suggestive paper dealing with the problem of isolation *versus* coincidence in the same group (the Chaetognatha) recently published by Michael (1913, pp. 17–50). The extensive collection of specific data with regard not only to latitudinal and longitudinal but also to vertical distribution permits the enunciation of the following principle (Michael, 1913, p. 18): " . . . Pelagic organ-

isms may be coincidently distributed as regards latitude and longitude, and still be completely isolated in their vertical distribution."

The results of Michael's work indicate that the increase of exact knowledge in at least one group of oceanic organisms has emphasized the possible significance to these organisms of isolation.

It is concluded (Michael, 1913, p. 46) that "Jordan's Law" is only partly true, when tested by vertical distribution, for while the most closely related species do not inhabit the *same* environment, they do inhabit the most *remote* environments; and that the more closely related species of Chaetognatha are isolated from each other either horizontally, vertically, or by virtue of physiological differences causing fertilization to take place in different strata of water.

Attention should be called to the following points in connection with the data presented on pages 465 to 472 of the present paper, at which the evidence apparently does not clearly harmonize with Wagner's theory.

Sorex halicoetes of the San Francisco salt marshes is separated from its closest relative, *Sorex vagrans vagrans* of the humid strip along the Pacific Ocean, by several miles of upland which is inhabited by *Sorex californicus californicus*. According to the strict requirements of Wagner's hypothesis, the ranges of the most closely related forms should occupy adjoining territory. If our interpretation of the relationship of these forms be correct, *Sorex californicus californicus* must be conceived of as having invaded the territory it now occupies at the expense of the *vagrans* stock, crowding the latter to one side or the other.

Island distribution offers many cases of broad gaps between the ranges of species most closely related, but in most cases these gaps were formerly nonexistent or else the closely related stocks in question formerly enjoyed some means of transversing them, or are able at long intervals still to traverse them, though not to the extent that there is a quashing of incipient differential characters through interbreeding. The same principle should be remembered in connection with distribution along mountain systems like the Sierra Nevada, where, for instance, the family Ochotonidae has a discontinuous distribution, being found only in certain "islands" of high Boreal.

Two very interesting and instructive cases are furnished by the *maniculatus* series of mice. The relations between *Peromyscus maniculatus gambelii* and *Peromyscus maniculatus rubidus*, as well as those between *Peromyscus maniculatus austerus* and *Peromyscus*

maniculatus oreas, are rather exceptional. Concerning the first case Osgood says (1909, pp. 69, 70):

> The transition from *gambeli* to *rubidus* along the line between their ranges is rather sudden, suggesting the possibility of hybridizing. From several localities specimens fairly typical of both forms are known, from others we have both forms and apparent intermediates, and from still others all specimens thus far obtained are intermediate not typical of either form. This is exactly what would be expected upon the theory of hybridism, but of course it cannot be considered as conclusive proof.

Concerning the second he says (pp. 52, 53):

> The case is very similar to that of *gambeli* and *rubidus* in California, the complications of which may be due either to hybridization or to intergradation. It is already known that *oreas* and *austerus* occur together at a number of localities and apparently maintain their respective characters. At other places only one form has thus far been found, at others extremes of both forms and intermediates occur, and at still others intermediates only. There is no environmental distinction as in the case of *gambeli* and *rubidus*, for *oreas* and *austerus* live under apparently identical conditions. Although only one form has been found at the respective type localities of *oreas* and *austerus*, both occur together near by, and further collecting may show that they do so over a wide area. Specimens which appear to be intermediate between *oreas* and *austerus* may in reality represent special differentiations of the one or the other showing accidental parallelism.

These cases are very puzzling, as the pairs of species mentioned are very closely if not most closely related to each other, and on Wagner's hypothesis should not occur together. Note should be made of at least two possible explanations: It may be that, having originated in different geographic areas, and having undergone some degree of differentiation, there has been re-invasion, and that, even though very closely related, they occupy slightly different ecologic niches, and are able to coexist in the same place because of some measure of physiological isolation. Or it may be that we have here an illustration of Mendelian inheritance in nature, the two subspecies crossing freely. The extreme rarity among higher vertebrates of this latter type of behavior where ranges overlap at their margins, would seem to constitute an argument for the first, rather than the second explanation, but the case is not entirely clear.

It will be remembered that *Mustela arizonensis* is found in the Transition and Boreal zones of the Sierra Nevada and the Rocky Mountain systems. On the Cascades and the Trinity Mountains its place is taken by *Mustela saturata*, a closely related form. Between the Sierra Nevada and the Rocky Mountains there would

seem to be a barrier far greater than that between the Sierra Nevada and the Trinity-Cascade mountains, and yet *Mustela arizonensis* is found on both the Rocky Mountains and the Sierra, but is replaced by another species on the Trinity-Cascades! It may be, of course, that the real efficacy of the Klamath River gap has not been appraised at its true value, and that the effectiveness of the barrier between the Rocky Mountains and the Sierra has been exaggerated.

Mephitis platyrhina, as previously stated, is found in the Sonoran valleys around the south end of the Sierra Nevada. This species might be conceived to have arisen through mutation, or Darwinian divergence, or physiological selection, from *Mephitis occidentalis holzneri*, the range of which partially overlaps the range of *platyrhina*. The following considerations, however, militate somewhat against these possibilities: (1) The speciation, that is, differentiation, of the skunk family as a whole seems to have been dependent on migration and geographical isolation. (2) The overlapping of the ranges of *M. platyrhina* and *M. o. holzneri* takes place over a narrow area only. (3) *M. platyrhina* seems to be most closely related, on the basis of its structure, to *M. o. major*, which occurs to the northward, and not to *M. o. holzneri* (Howell, 1901, p. 39).

One other case: There occur along the Pacific Coast three species of the mammalian genus *Aplodontia*, very intimately related one to the other, less intimately related to the members of the genus found in the interior mountains (*Aplodontia californica* and *A. chryseola*). The coast species referred to are *Aplodontia pacifica*, Yaquina Bay, Oregon; *Aplodontia nigra*, Point Arena, California; and *Aplodontia phaea*, Marin County, California.

In the case of these forms the Sierran or mountain stock has evidently moved westward into the Siskiyou and Trinity mountains, where it is represented by the species *chryscola*, and even to the coast itself, where it is represented, in the Humboldt Bay region, by an undescribed form nearly identical, cranially, with *chryseola*. Thus the ranges of the closely related *A. pacifica* of Oregon and *A. nigra* of Point Arena, California, are separated by the *chryseola* stock, which must thus, on the Wagnerian hypothesis, be thought to have carried the western boundary of its range to the sea since the *pacifica-nigra-phaea* stock attained its broad coastwise distribution.

It is noteworthy that in all these critical cases there is not a sufficient quantity of fossil and Recent material for the adequate elucidation of their relationships. This is especially apparent with the weasels, skunks, and aplodonts just cited. On the other hand, in cases where material is abundant and the status of the forms is reasonably well established, the great mass of facts of distribution harmonizes with Wagner's theory.

How Have Different Ecologic Niches Been Filled?

It should be remembered, of course, that had living forms not possessed the power of adapting themselves or becoming adapted to different ecologic niches we would not have had the various niches filled. But the evidence from mammals and higher vertebrates would seem to indicate that geographic isolation is prerequisite to any kind of differentiation; physiological isolation, or practical sterility, being gradually assumed in proportion as the completeness and long continuance of geographical isolation, and the association of it with diversity of external conditions, permit or condition morphological changes extending to the reproductive system. The broader the distribution of the species and subspecies of any group of mammals or higher vertebrates, the greater the probability that some of the forms will find themselves in ecologic niches which, while they resemble in a general way the original group niche, will still differ from it in some important particulars. In strict terms, no two ecologic niches, situated in different geographic areas, can be precisely the same.

Thus it may be noted that while the so-called *panamintinus* group of the genus *Perognathus* occupies the same *general* ecologic niche wherever found, as a matter of fact, the particular ecologic niche occupied by each species or subspecies is somewhat different from that occupied by any of the other species or subspecies. Grinnell and Swarth (1913, pp. 390, 392) have listed in their "fourth category", Table D, a number of forms of birds and mammals of which also this may be said to be true, and in the opinion of the writer study of group distribution in vertebrates shows this to be a rule of practically universal applicability.

The status of things may be graphically represented by a diagram, as in fig. Q. Let the capital letter stand for the stock or species, the lower-case letter represent the ecologic niche it occupies, and the arabic numeral the geographic area in which the ecologic niche is

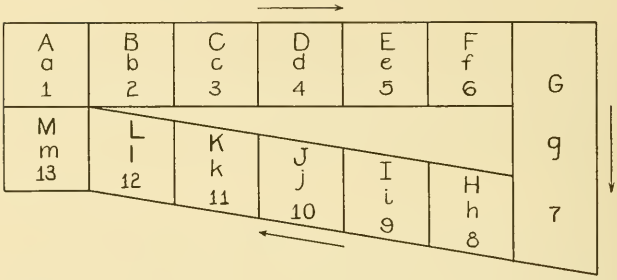

Fig. Q. Diagram illustrating possible explanation of presence of related forms in same locality.

located. The vertical lines represent geographical, the horizontal and slanting lines physiological barriers. Thus we have 1, 2, 3, 4 and so on, contiguous geographic areas, each separated from the other by some sort of geographic barrier. If A is the primitive mammalian stock, then B may be regarded as a stock which accidentally or otherwise has become geographically separated from it, and finally has become differentiated into a separate species. The continuation of this process of migration and differentiation may be conceived of as resulting in species G, which has become so far differentiated from the original stock A as not to be included in the same subgenus with it.

The ecologic niche *b*, occupied by species B, will be slightly different from niche *a*, in which the primitive stock is found. That occupied by species C will differ slightly from that occupied by B. This very slight difference in ecologic niche will be apparent up to and including *g*, in which species G, which has attained a quite considerable divergence, is found.

Thus the series of niches, into which members of the subgenus of which species G is representative will be able to enter, will be somewhat different from the series to which members of the subgenus of which species A is representative will have ready access. Thus it may happen, through a further continuation of the process of migration and differentiation, that species H to M, members of the G subgenus, may arise, and there may even be a re-invasion, on the part of some member of the G group, as for instance M, into the geographic area occupied by original stock A. But M will have

become considerably differentiated from A, and probably will be physiologically isolated from it, and furthermore, will not be under the necessity of competing with A, except in the most general way, for it will be fitted to occupy ecologic niche *m*, which is different from ecologic niche *a*. Two species derived from the same original stock will thus be found occupying different ecologic niches in the same place. The closest relatives of each will be found, not in the same locality but in a neighboring area, the races or species being kept separate by a geographic barrier of some sort. Thus B is A's closest relative, and L is M's closest relative.

It is to be doubted whether an actual series of cases completely illustrative of the steps in such a differentiation and re-invasion can ever be demonstrated in nature. The process is an extremely complicated one, as a moment's consideration will show. The diagram is purposely made very simple; in nature the process must be exceedingly complex. The primitive stock and its descendants are subject to all the vicissitudes of environmental and topographic change, and the process as above outlined would not only require an enormous time for its fulfillment, but would depend upon the existence of spatial relations of exactly the right sort. Possible contingencies in a great many directions are numerous.

The great weight of evidence from the study of mammals and higher vertebrates would seem to indicate that the occupation of different ecologic niches in the same place has in every instance been the result, not of some process of adaptation of a portion of the parent stock to a distinct ecologic niche, and the differentiation of this adapted portion while both were living in the same locality, but of some comprehensive process similar to the hypothetical one above presented, involving migration, differentiation, and re-invasion.

If, as we believe the evidence indicates, geographic isolation is, in the higher vertebrates, a condition essential to specific differentiation, then on the assumption that the classes of vertebrates are descended from one or a very few original stocks it follows that these migrations, differentiations and re-invasions have been very extensive. For there are many ecologic niches in almost every locality which are now occupied by various mammals, or birds, or reptiles. It has been long recognized, of course, that there have been numerous migrations and differentiations. But has due recognition been accorded the principles of invasion and re-invasion? Unless there had been, according to the logical continuation of the

two propositions (geographic isolation a condition to divergence in higher vertebrates; classes of vertebrates descended from one or a very few original stocks) extensive invasions and re-invasions, each geographical locality would now be occupied by one mammal, or one bird, or one reptile, only.

Following out this thought it would appear that there have been as many mammalian invasions or re-invasions for each locality as there are species or subspecies of mammals within it—unless so large a locality is taken as to contain barriers which would serve to isolate portions of the stocks from each other. This would seem to afford a confirmation from the standpoint of the theoretical necessities of isolation, of the axiom, stated by Grinnell (1914, p. 98) to be a necessary result of the ever-shifting location geographically of associational, faunal, and zonal conditions; this axiom is that "every single element or line of descent, now represented in the biota of any locality, must have come either in its present form or in some antecedent one from somewhere else."

In almost every locality there are ecologic niches which are unoccupied. In many instances there exist animals which could occupy these niches if they could get to them; but barriers of one sort or another effectually prevent their getting to them. This constitutes an important line of negative evidence which is complementary to the positive line. If an organic stock were capable of divarication in a single locality, given geologic time all occupiable niches ought to have been filled.

Of course the species resident in a locality might and probably would become modified monotypically through a progressively changing environment or from some other cause or causes, but there would never ensue any differentiation. To increase the number of species or subspecies of mammals in the locality further invasions or re-invasions are called for.

Tentative Suggestions Regarding the Manner in Which Geographic Isolation Acts in the Process of Speciation

Although in most cases laboratory work is done with forms low in the organic scale, and it is questionable how broadly the conclusions based upon such work may be applied, some of the results of experimental work are exceedingly suggestive as to what may be taking place in nature in widely separated classes of organisms. As Thomson says (1909, p. 329), "The world of organisms is very

large and heterogeneous, and results that hold good for certain forms of life may not be true of others." The variety of the living world seems to be no less characteristic than its unity; so it would seem appropriate that workers in science should be very chary of launching generalizations as universals.

Feeling, however, that one of the most pressing of present-day needs in biology is the correlation of the work of the "experimentalist" and the "naturalist", the writer is led to submit the following suggestions, incomplete though they may be.

When we face the question of the manner in which geographical isolation works, some of the results of Tower's experiments with beetles of the genus *Leptinotarsa* (1906) and of MacDougal's work with plants of the genus *Raimannia* (1906, p. 422) are of great interest. It will be remembered that Tower, by subjecting his beetles to varying conditions during the growth-period of the germ-cells, effected the production of new species and new characters. Although the parents were unaffected, their germ-cells were modified, and the offspring grew up different. MacDougal injected salt solution into the ovules of *Raimannia* just previous to fertilization, securing potentially new species as a result of the chemical and osmotic action exerted on unfertilized ovules. Tower, commenting on this case (1906, p. 295), says: "These results of MacDougal's exactly confirm in plants the results that I have obtained in these beetles, so that the point is now doubly certain that heritable variations are produced as the direct response to external stimuli."

Our studies of the distribution of higher vertebrates invite the belief that in the majority of cases differentiation follows migration and, clearly in most instances, the exposure to different environmental conditions. There is thus suggested a possible partial agreement between these two apparently widely sundered classes of observational facts. What has caused the differentiation which we observe in the higher vertebrates? The application of the principles of Independent Generation, Independent Variation, or *Amixia* (these three synonymous terms standing for differentiation under similar conditions in virtue of geographic isolation alone) to these classes of organisms is probably limited. These animals usually range so widely that there are obvious environmental differences associated with difference in species. The facts of geographical distribution of higher vertebrates do not militate against Tower's

conclusion that heritable variations are produced as a direct response to external stimuli, even if they cannot be shown directly to favor it.

It is noteworthy that Tower insists that although heritable variations are produced as a direct response to external stimuli, the response itself is absolutely determined within the organism. To quote his own words (1906, p. 295):

> It is true that different intensities of the same stimuli call forth different responses, but, as is shown in the chapter on coloration, the response is entirely determined within the organism, which is adjusted to different intensities of stimuli and reacts according to its own method and on the basis of its own constitution, there being no specific reaction called forth by a given stimulus.

The facts from the study of the zoogeography of the higher vertebrates appear to harmonize with these conclusions of Tower's. As the evidence becomes more complete it appears more and more clear that Darwin was right in assigning to the "nature of the organism" a more important place in considerations of speciation than that accorded the "nature of the conditions".

Do we not have here a suggestion as to how isolation works? The shaping of the species seems to depend upon two things primarily: (1) the nature, rapidity, and intensity of the blows from the environmental hammer; and (2) the nature of the organism itself. Thus isolation apparently operates, in the higher vertebrates, by segregating different sorts of environments and insuring their continued moulding of the particular segregated lots of individuals. On passing from one faunal area, association, or life-zone to another we encounter different, but closely related species. Thus differences between geminate species (Jordan, 1908) are apparently dependent upon the fact that differential environmental hammers have been used on what was originally the same stock. On making a comparison of this sort, we note that there has been great diversity of response on the part of the different members of the assemblage to the same environmental complex. The entire assemblage in any given district has been subject to the same environment, but the assumed differences in the stuffs moulded in each case readily account for the fact that all have not responded in the same way.

Tower (1906, pp. 286–296) found that by subjecting a given species of potato beetle to unaccustomed environmental stimuli there resulted in the offspring a break-up into several forms, some

of which resembled the parent stock and others of which exemplified potentially new species. For example, when *Leptinotarsa decemlineata* was so treated there was a break-up in the next generation into *Leptinotarsa immaculothorax*, *L. pallida*, and the unmodified *L. decemlineata*. The evidence from the zoogeography of the higher vertebrates clearly indicates, as has been repeatedly stated and implied, that isolation of one portion of a parent stock and subjection of it to the conditions of one new environment, results in the differentiation of but *one* new form, and that until further migration has effected the further isolation of the stock and its subjection to some other environment there is no further polytypic evolution.

A further implication contained in the work of Tower should be mentioned here. The modifications were definitely brought about in his experimental work through the action of the unaccustomed environmental stimulus during the period of growth and maturation of the germ-cells, and at no other time. This invites one to the suggestion that the environment may do its work by bringing pressure to bear directly or indirectly on the germ-cells, and that environmental-somatic impacts may be of no moment in speciation if they are not conveyed to the germ-cells. The failure of environmental-somatic impacts to be translated into environmental-germinal impacts may explain the permanence of subspecies amid conditions very different from those to which they are accustomed. *Ammospermophilus leucurus leucurus*, for example, having its center of distribution on the Colorado Desert, ranges notably over into the damper San Diegan faunal area, maintaining its desert characteristics even under the moister conditions (see Grinnell and Swarth, 1913, pp. 391–394). Evidently, however, such a translation of environmental-somatic impacts into environmental-germinal impacts has taken place in most cases in the past, and may perhaps be anticipated to take place, where it has not yet done so, at some time in the future.

As water, constantly dropping, wears away the stone, so the environment, through constant and continuous re-impression, seems to find at last some avenue to the germ-cell, until, as believed by most students of zoogeography, it becomes true that differentiation has come to be a part of the connotation of geographical isolation.

That the differentiation of which geographic isolation is a condi-

tion is cumulative, is indicated by a great many facts from zoogeography. Species known to have originated recently, as for example, those in neighboring areas separated by a barrier not absolute, are structurally much more alike than species known to have been separated for longer times. Thus *Castor subauratus shastensis* and *Castor subauratus subauratus*, occupying neighboring areas, and only recently separated, are structurally much more alike than are *Castor fiber* and *Castor canadensis canadensis* occupying areas in different continents, and separated for a much longer time. Island forms of mainland stocks are often poorly differentiated, the degree of divergence seeming in a measure to be associated with the length of time of separation of the island from the mainland. This cumulation is, of course, only within limits, for there are notable examples of very long separation with comparatively little differentiation, and even a few cases wherein long separation has apparently failed to bring about any differentiation whatever.

To summarize the remarks in this section: It may be conceived that isolation works with organisms in nature in some such way as the experimentalist works with organisms in the laboratory. The latter isolates a number of individuals and subjects them to a diversity of surroundings known as the conditions of the experiment. In nature the parent stock becomes separated, by some means or other, natural barriers corresponding to the walls of the container or of the laboratory, and the different environmental conditions in new territory occupied, corresponding to the conditions of the experiment. Differentiation may ensue in either case. In the higher vertebrates, at least, it has ensued practically in all cases. Geographical isolation probably conditions differentiation by segregating organism and environment together and maintaining their mutual interrelations over long periods of time.

Evidence from geographic distribution of higher vertebrates does not oppose, if it does not definitely support, the thesis that speciation is dependent on modification in germinal constitution. It appears to present unequivocal data that the response to the different environments depends upon the nature of the organism. It furnishes a mass of evidence against the theory of the possibility of the appearance of a new species in territory occupied also by the parent, so emphasizing the necessity of migration and geographic isolation as conditions of polytypic evolution. It indicates that

the differentiation conditioned by isolation is, within limits, cumulative.

As remarked previously, these conclusions are drawn up simply as a possible means of assisting in understanding the enormous and complicated body of facts concerning the speciation of the higher vertebrate animals, and may or may not hold for other classes of organisms.

Summary

1. The ranges of seven recognizably differentiated subspecies of beavers touch upon, or lie close to, the Pacific Ocean in western North America.

2. Since beavers grow throughout their life, the consideration of changes in form, outline, and dimensions of the various parts due to difference in age becomes especially important. There is little change in coloration with age.

3. The beavers possess a highly specialized dentition, as is shown by the following facts: (1) the permanent dentition exhibits a high degree of hypsodonty, though the milk teeth are brachydont; (2) the enamel-fold pattern of the cheek-teeth is much complicated; (3) the dental formula is much reduced. The generalized mammalian formula is $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3} \times 2 = 44$, while that of the beaver is $I\frac{1}{1}$, $C\frac{0}{0}$, $P\frac{1}{1}$, $M\frac{3}{3} \times 2 = 20$. During ontogeny, the continuously growing cheek-teeth first increase in size, then decrease slightly. There are no important differences due to age in the proportional relation of the antero-posterior to the transverse diameter of the teeth. The dental armature is a cutting and grinding agency of high efficiency.

4. The similarly rounded instead of plane conformation of the palato-maxillary region, and the similar complication of the enamel pattern of the cheek-teeth in the Sciuromorph genus *Castor* and in the Hystricomorph genus *Erethizon* appear to be parallel adaptations: the first condition being an adaptation to the stripping of the bark from twigs and branches, the second to the effective mastication of this food.

5. Certain readjustments of current systematic conceptions of beaver status are necessary:

(1) The race of beaver inhabiting the Cook Inlet region of Alaska and ranging south into northern and central British Colum-

bia is here characterized as a new subspecies, *Castor canadensis belugae*.

(2) The race of beaver inhabiting the Pit River region of California, east of the Sierra Nevada, is here characterized as a new subspecies, *Castor subauratus shastensis*.

(3) The race of beaver inhabiting the mainland of Washington and Oregon is shown to be subspecifically distinct from the form on Vancouver Island (*Castor canadensis leucodonta* Gray) requiring the rehabilitation of Rhoads' name *pacificus*.

6. The fragmentary palaeontologic history of the Castoridae points to at least three intermigrations of beavers between the Old World and the New. *Steneofiber* appears in the middle Oligocene of Europe, and in the upper Oligocene of North America. The *Eucastor-Dipoides* stock appears in the upper Miocene of North America, and in the Pliocene of Asia. *Castor* first appears in the Pontian upper Miocene of Europe, but in North America it does not appear until later, its first known occurrence being in the Pliocene of California. In the case of each of these genera, at least one intercontinental migration is indicated.

7. The beavers of North America (those of which material has been available) are separable into two groups: the *canadensis* group, with subspecies *canadensis, michiganensis, belugae, leucodonta, pacificus, frondator,* and *texensis;* and the *subauratus* group, with subspecies *subauratus* and *shastensis*. The forms making up the *canadensis* group are unequally related.

8. On the whole, differentiation in the genus *Castor* is slight. The California stock has undergone more divergence than any other.

9. A consideration of its history and present status shows that the widest diversity of opinion as to the isolation concept still prevails, and emphasizes the necessity for more critical enquiries concerning it.

10. The evidence from beavers, and higher vertebrates generally, regarding Weismann's *Amixia*, Romanes' Independent Variability, and Gulick's Independent Generation, is inconclusive. In the case of beavers it must be conceded, however, that the possibility is by no means excluded that geographical isolation alone has been the chief condition in speciation.

11. The bulk of the evidence from the zoogeography of beavers and other vertebrates seems to indicate that polytypic evolution in these groups has been conditioned by the spatial partition of the

originally uniform stock as required by Wagner's isolation theory. If any one of the following factors, (1) "advantage of divergence" as Darwin used the term, (2) De Vriesian mutation, (3) Mendelian segregation, (4) physiological selection, has been operative in the differentiation of higher vertebrates, it is not apparent in the data of distribution. In these higher groups differentiation becomes, sooner or later, a part of the connotation of geographic isolation.

12. A corollary of the proposition just stated is that in beavers, and in higher vertebrates generally, geographic range is exactly as characteristic of species as any physical or psychical attribute.

13. Any definite conclusions regarding certain problematic cases would be premature. Much more testimony must be taken before a decision is reached. Such rare occurrences as that of *Peromyscus maniculatus orcas* with its closest relative *Peromyscus maniculatus austerus* in the same territory are susceptible of interpretation according to one of two alternatives: (1) the case may be one of speciation in accordance with Darwin's, De Vries', or Romanes' theories, the two species being preserved intact through Mendelian segregation; (2) the speciation may have proceeded according to Wagner's theory of geographic isolation (that is, by migration, geographical isolation, and differentiation); the physiological isolation between them may be but partial; and there may have been a re-invasion on the part of one into the range of the other.

14. Certain experimentalists, as Tower and MacDougal, have subjected parent generations of insects and plants to unaccustomed environmental stimuli, the offspring showing new characters and assumed to represent new specific types. The distribution of the higher vertebrates seems to make it certain that in the majority of instances differentiation follows migration, and, clearly in most cases, subjection to different environmental conditions. It looks as if in both cases heritable variations are produced as a direct response to external stimuli, the response in each case depending on the nature of the organism.

15. If this be the case, geographic isolation works no less by segregating different environments than by separating different lots of individuals. Stated differently, geographic isolation conditions differentiation through its maintenance of the mutual interrelations of organism and environment through long periods of time.

16. Zoogeography does not furnish evidence whether or not

the only effectual environmental impact is that which is received by the germ-cells; therefore it is not opposed to such a conclusion, already reached experimentally in widely different groups of organisms.

17. There is evidence from vertebrate zoogeography that indicates the cumulative character of the differentiation associated with geographic isolation.

18. The different ecologic niches in the same locality, so far as they are occupied by a given class of organisms, would seem to have been filled, not through processes of differentiation and adaptation in that single locality, but through those of migration, geographic isolation, differentiation, concurrent adaptation to different niches, and final invasion or re-invasion of the locality in question—to occupy different niches there. If geographic isolation is a condition essential to speciation in the higher vertebrates, and if each class of the higher vertebrates is derived from one or a few ancestral stocks, it follows that the tracing of these processes is highly important if not indispensable, either to an adequate understanding of the course of development of the class, or to a thorough conception of any particular facies of the class. Among these processes the principles of invasion and re-invasion, which are apparently of great significance in explaining the class-assemblage of a given locality, have been less emphasized than their importance deserves.

Transmitted November 18, 1914.

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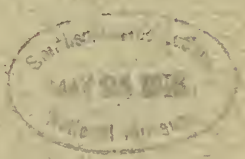
BY
WALTER P. TAYLOR



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TWO NEW APLODONTIAS FROM WESTERN NORTH AMERICA

BY
WALTER P. TAYLOR

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Smithsonian
MAY 26 1916
National Museum

The genus *Aplodontia* is found west of the Sierra Nevada–Cascade mountain system from southern British Columbia on the north to middle California on the south. Study of specimens of the genus from the northern part of the range demonstrates the existence there of two subspecies hitherto unrecognized. The writer desires to express his thanks for the loan of material to the authorities of the Field Museum of Natural History, especially to Mr. Wilfred H. Osgood, to those of the Museum of Comparative Zoology, particularly to Messrs. Samuel Henshaw and Outram Bangs, and to those of the Bureau of Biological Survey of the United States Department of Agriculture, especially to Messrs. H. W. Henshaw and E. W. Nelson. He is also indebted to the authorities in charge of the Museum of Comparative Zoology, particularly to the director, Mr. Samuel Henshaw, for the privilege of describing a new subspecies of *Aplodontia* on the basis of material loaned.

Aplodontia rufa grisea, new subspecies

Puget Sound Mountain Beaver

Type.—Female adult, no. 3751, Mus. Vert. Zool.; Renton [near Seattle], Washington; October 4, 1907; collected by Frank Stephens; orig. no. 294; stuffed skin, with skull and jaws, all in good condition, except hamulars broken.

Diagnosis.—Similar to examples of *Aplodontia rufa rufa*, but paler, grayer; separable from *Aplodontia rufa olympica* through ab-

sence of distinct postorbital processes on the jugal; smaller than *Aplodontia californica columbiana* and *Aplodontia californica rainieri.*

Comparisons.—In examples of *Aplodontia rufa grisea* the brown coloration ranges from light ochraceous-buff to light buff, while in *A. r. rufa* the range in coloration is from near tawny to light ochraceous-buff; *grisea* for the most part lacks the distinct brown wash so often present in *rufa.* Cranially, *grisea* tends to have interpterygoid fossa narrower than in *rufa,* audital tube of smaller caliber, postorbital process indicated on the jugal in some specimens, and lesser mastoid width.

Aplodontia rufa grisea may be separated from *A. r. olympica,* in the usual instance, only by the different development of postorbital process on the jugal. In *grisea* these processes are weakly indicated in a few examples, in *olympica* they reach their maximum of development in the genus. Even this character cannot always be relied upon as certainly separative, since the postorbital processes are sometimes weakly developed in *olympica.* Available skins of *grisea* and *olympica* are not strictly comparable, for the majority of the specimens of *grisea* were collected in winter, and the series of *olympica* was taken in summer. Seasonal variation in the genus is usually exceeded by individual variation, however, so cross-comparisons may perhaps legitimately be made. A summer skin of *grisea* from Sumas, British Columbia (no. 88008, Biol. Surv. Coll.), is identical in coloration with certain summer specimens of *olympica.* Comparison of this skin with the entire series of examples of *olympica,* however, demonstrates the presence of more blackish dorsally in the latter and more of a tendency toward a brown wash ventrally.

Aplodontia rufa grisea is smaller than *Aplodontia californica columbiana* in both external and cranial characters, with slighter tendency to whitish ventrally; tendency for zygomatic and mastoid widths to be more nearly equal, lesser tendency to accentuation and approximation of temporal ridges, and incisive foramina tending to be shorter. From *A. c. rainieri, grisea* is separated by smaller size and by having basilar length averaging less, maximum length of nasals in *grisea* about equal to minimum in *rainieri,* nasals tending to be narrower anteriorly and posteriorly, interpterygoid fossa averaging narrower, mastoid width of cranium averaging less, conformation of rostrum more plane.

Material.—Fourteen specimens, as follows: one (no. 88008, Biol. Surv. Coll., taken by A. C. Brooks) from Sumas, British Columbia;

four (no. 94348, Biol. Surv. Coll., and nos. 6822, 6824, and 6825, Mus. Comp. Zool., all taken by A. C. Brooks) from Chilliwack, British Columbia; one (no. 6823, Mus. Comp. Zool., taken by A. C. Brooks) from Mount Baker Range, British Columbia; one (no. 7388, Field Mus. Nat. Hist., taken by L. M. Turner) from Ravenna, Washington; three (nos. 3749–3751, Mus. Vert. Zool., taken by Frank Stephens) from Renton, near Seattle, Washington; four (nos. 7385–7387, Field Mus. Nat. Hist., taken by E. C. Starks, and no. 3748, Mus. Vert. Zool., taken by Frank Stephens) from Seattle, Washington.

Measurements.—Of type (adult female): total length, 330 mm.; tail, 25; hind foot, 55; basilar length, 59.1; length of nasals, 26.7; width of nasals, 11.7; length of audital tube, 19.6; length of incisive foramen, 7.2; zygomatic width, 57.5; greatest width of interpterygoid fossa, 5.3; mastoid width, 52.5; alveolar length of superior cheek teeth, 19.6; distance between infraorbital foramina, 15.2; mandible, transversely across angular process, 22.3; greatest length of mandible, 49.5.

Remarks.—*Aplodontia rufa grisca* of the Puget Sound and Sumas districts is apparently nearest to *A. r. olympica* of the Olympic Mountain region. The characters of the Puget Sound form intergrade not only with those of *A. r. olympica* but also with those of *A. r. rufa* of the lower Columbia River.

Specimens referred to *Aplodontia rufa grisca* from Sumas, Chilliwack, and the Mount Baker Range, British Columbia, show tendencies toward greater dimensions in some respects, and are otherwise untypical, indicating a slight geographic variant in that region.

Although *Aplodontia rufa grisca* is not strongly marked at best, its relationships would seem to be indicated more accurately by its recognition as a subspecies of *rufa* than by its direct reference to that form.

Aplodontia californica columbiana, new subspecies

British Columbia Mountain Beaver

Type.—Male adult; no. 1899, Coll. E. A. and O. Bangs, Mus. Comp. Zool.; Roab's Ranch, Hope, British Columbia, June 14, 1894; collected by W. C. Colt; stuffed skin, with skull and jaws, in good condition, except skin with foreleg injured in trap, skull with left audital tube, region of foramen magnum, and hamulars somewhat injured.

Diagnosis.—Similar to *Aplodontia californica rainieri*, but larger; males having white patches beneath; nasals tending to be longer and

broader, zygomatic arches heavier and more expanded at posterior root, caliber of audital tubes tending to be less, a more pronounced tendency apparent toward approximation of temporal ridges, less of a hollow in skull outline dorsally (looking at skull in side view).

Comparisons.—In coloration dorsally *Aplodontia californica columbiana* is not conspicuously or appreciably different from *A. c. rainieri*. The tendency observable in males of *columbiana* to have irregular patches of white hair beneath is not expressed in available examples of *rainieri*. Total length externally is nearly 14 per cent greater in *columbiana*, figured on the basis of the total length in the type of *rainieri* and that in nine specimens of *columbiana*. The following cranial measurements average greater in *columbiana* than in *rainieri:* length and width of nasals, length of incisive foramina, zygomatic width, mastoid width, and greatest length of mandible. Available material shows the length of nasals in *columbiana* to be absolutely greater than in *rainieri*.

From *Aplodontia californica californica* the British Columbian form is distinguished, among other characters, by its larger general size, and by having, in the usual instance, zygomatic arches less square anteriorly, lighter in weight and more expanded in the region of the posterior root, caliber of audital tubes less, and external auditory meatus of different shape.

Comparison with *Aplodontia rufa grisea* is perhaps not strictly necessary. From this race *A. californica columbiana* is separated by the more pronounced tendency observable in *columbiana* to have irregular white patches beneath, by larger size in general, different outline of nasals, heavier zygomatic arches and their greater expansion posteriorly, lesser caliber of audital tubes, and different outline of external auditory meatus. The last-mentioned character is a conspicuous one, the meatus in *columbiana* being pinched up anteroposteriorly, making the dorsoventral diameter of the meatus greater than the anteroposterior. In *grisea* the outline of the meatus approximates a circle.

Material.—Nine specimens, all from British Columbia: four (nos. 1892–1895, Mus. Comp. Zool., taken by W. C. Colt) from Lake House, Hope; five (nos. 1896–1900, Mus. Comp. Zool., taken by W. C. Colt) from Roab's Ranch, Hope.

Measurements.—Of type (adult male): total length, 470 mm.; tail, 22; hind foot, 20; width of nasals, 13.0; length of incisive foramen, 7.8; zygomatic width, 66.0; mastoid width, 61.2; alveolar length

superior cheek teeth, 19.5; distance between infraorbital foramina, 16.6; mandible, transversely across angular process, 25.2; greatest length of mandible, 50.2.

Remarks.—*Aplodontia californica columbiana* is a strongly marked form, being in general the largest species of mountain beaver described up to the present time. It averages above the maximum in any other species or subspecies in length of nasals, zygomatic width, and, with only two exceptions, in mastoid width. In total length externally it averages decidedly above the maximum in any other race.

Although it is true that so far as at present known there are broad gaps between the geographic ranges of the three subspecies of *Aplodontia californica*, and that no intergradation between them has been demonstrated, nevertheless their mutual relationships as well as their status with reference to other forms of the genus would seem to be best shown by referring them all to this species.

Transmitted February 28, 1916.

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NOTES ON THE LOCAL DISTRIBUTION AND HABITS OF THE AMPHIBIANS AND REPTILES OF SOUTHEASTERN CALIFORNIA IN THE VICINITY OF THE TURTLE MOUNTAINS

BY

CHARLES LEWIS CAMP

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BY
CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

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INTRODUCTION

A prominent feature in the topography of southeastern California is a chain of rugged hills known as the Turtle Mountains. These lie thirty miles west of Parker, Arizona (on the Colorado River), and extend north from the San Bernardino-Riverside county line for about forty miles. The author's survey of this particular part of the desert extended over a period of nineteen days, in May and June of 1914. In July, 1909, a day was spent at Goffs, a station on the Santa Fe Railroad thirty miles west of Needles, California, and about sixty miles north of Blythe Junction. At the latter point, on the Parker branch of the Santa Fe, six days were spent in June, 1914. At all these places especial attention was paid to the vertebrates. Altogether one hundred and thirteen specimens of reptiles and amphibians were

collected; these comprise twenty species. Habit notes were recorded at time of observation. The Turtle Mountain work was undertaken for the purpose of studying a definite fauna in an arid locality, where animal habitats are reduced nearly to simple topographical terms. (See map, pl. 19.)

All the specimens obtained have been added to the collection of the California Museum of Vertebrate Zoology, and it is under the numbers of this Museum that they are individually referred to in this paper. To the Director of this institution, Dr. Joseph Grinnell, the writer wishes here to express appreciation for criticism and general supervision during the preparation of the manuscript.

The color names used in this paper are taken from Ridgway's (1912) *Color Standards and Color Nomenclature*.

The desert bordering the lower Colorado River, its tributaries and distributaries, is not subject to the low winter temperatures prevalent in other continental parts of the United States, and it seems reasonable to suppose that this high winter (as well as summer) temperature might account for the greater number of species of lizards in the Colorado Desert than in the higher and colder Mohave Desert, the more enclosed and colder Death Valley region, and the plateaus of Nevada and Utah, farther north. Certainly the climate of the regions mentioned appears to differ in no other decided respect than in winter temperature, and this makes it seem likely that the latter must be reckoned as an important control in the distribution of saurians. Climatic characteristics of the Colorado Valley are: moderate winter and very high summer temperatures, during both night and day, scanty and sporadic rainfall, very low relative humidity and much air

CLIMATOLOGICAL TABLE

(Compiled from Bulletins L and W, U. S. Weather Bureau)

Locality	Altitude (feet) above sea level	Mean annual rainfall: inches	Mean annual rainfall: from	Mean annual temperature F.°	Mean relative humidity	Mean July temperature F.°
Yuma, Arizona	141	3.31	1870–1907	72.1	57% 8 a.m. 36% 8 p.m.	90.9
Parker, Arizona	375	4.12	1894–1907	71.0	.....	92.5
Needles, California	477	3.49	1892–1908*	73.0	.....	94.0
Mohave, California	2751	4.79	1877–1900	.....	.....	.....
Mammoth Tank, California	257	1.99	1878–1908	76.0	.....	98.5
Los Angeles, California	293	15.86	1878–1909	60.3	79% 8 a.m. 64% 8 p.m.	67.4

* There are at Needles only eleven days in the year on the average with .01 inches or more of rain.

movement, the last two resulting in a high rate of evaporation. Nowhere in the United States are lizards so numerous, both in species and individuals, as along the lower Colorado River.

The Turtle Mountains have never been surveyed. They rise to certainly not more than three thousand feet above the lowest surrounding depressions, the latter being about nine hundred feet above sea-level. At no points are their summits high enough to support the piñon and golden-oak associations such as occur on nearby desert mountains. Detrital materials washed from the slopes, and lying up against the hill-sides in great fans, nearly bury the lowest passes. In many places beds of brown scoriaceous rock cover the alluvial slopes and mountain sides. Farther out on the plains are stretches of gravelly ash peppered with lapillae. The scoriae are glossy and reflect much heat on bright days. Igneous rocks make up a large part of the mountain mass and there are a few eroded volcanic plugs, up to four or five hundred feet in diameter. Other formations occurring in some abundance are granites, quartz ledges, and, in the cañon bottoms, conglomerates; the latter, judging from their position, are of recent formation.

The hillsides are uniformly steep. They are covered with loose rocky material and retain but little soil. The cañon beds are boulder-strewn and often very narrow. At their mouths they are encroached upon by alluvial fans. These mesa-like benches are covered with scoriae, or with smooth pavements of flat pebbles, and show little soil on the surface. The arroyos dissecting the mesas are uniformly broad and sandy, giving evidence of copious, even though rare, floods. Undercut caves in the solidified gravels of the wash banks are frequently present at various levels above the wash floor. These holes furnish homes for the rough-scaled lizards and the desert wood rats (*Neotoma*), the latter industrious rodents being responsible for loosely piled accumulations of stones and dead twigs in and about the caves (see pl. 21, fig. 5).

The typical desert plains vegetation is not supported on the leached sand of the washes, which, probably because it is poor in nitrogen, has a distinct flora of leguminous plants such as palo verde (*Cercidium torreyanum*), smoke tree (*Dalea spinosa*), and ironwood (*Olneya tesota*). On the gravelly surface of the plains grows that most abundant of all desert plants, the creosote bush or greasewood (*Larrea tridentata*). Wash deltas and gentle slopes lying above 2000 feet in elevation usually bear, in addition to the creosote, stands of the long-

leafed tree yucca (*Yucca mohavensis*), a smaller species than the twisted form so common on the western stretches of the Mohave Desert.

Long belts of drifting sand traverse the California deserts at various places. These obviously owe their geographic position to the prevailing direction of wind, in connection with the place of occurrence of original stream deposits. Running east and west two miles south of Blythe Junction is a wind-drifted strip of fine sand blown into small dunes that are being carried eastward across the desert. In places this eolian material has been driven up over mountains and forms white cascades down their eastward slopes. The flora of the dunes south of the Turtle Mountains is dominated by a large species of *Ephedra*, or desert tea, and bunches of the wiry "galleta grass."

The plant and animal associations (see Ruthven, 1907, and Grinnell, 1914) in the region under discussion can be definitely correlated with the terrain, and the two together may conveniently be classed as *environments*, of which the following eight, at least, may be recognized in this region (see pl. 19).

(1) The rocky hillside environment, characterized by the low, pale, rounded shrub *Encelia*, and a small species of *Ephedra*.

(2) The cañon-bed environment, with the green catclaw (*Acacia*) as its most typical plant.

(3) The rocky mesa environment, possessing few species of either plants or vertebrate animals.

(4) The wash-bed environment, which is a direct continuation outside the mountains of the cañon bed and is in general slightly below the level of the rocky mesa. The characteristic association of leguminous desert trees lives in this environment.

(5) The low plain environment, distinguished by the predominance of the creosote bush (see pl. 20, fig. 3).

(6) The high plain environment, with the tree yucca, in addition to the low plain flora (see pl. 20, fig. 2).

(7) The drifting-sand environment, supporting a large *Ephedra* and patches of galleta grass (pl. 21, fig. 4).

(8) The cañon spring environment, represented in this region only by the three or four permanent springs of the Turtle Mountains, and characterized by the hydrophilous arrowweed association.

The water-supply, except after the rare showers, is extremely scanty. Behind dykes in three or four of the larger cañons feeble but lasting springs issue from the wash gravel. At some times of the year water can be found under the sand, or exposed in "tanks," pot-

holes hollowed out of the rock by stream action, and shaded by surrounding cliffs.

The desert terrestrial animals are for the most part independent of water; those apparently needing it, during the summer at least, are: coyotes, foxes, badgers, bob-cats, bighorn, and quail. The animals which fly to the water holes are perhaps more numerous, and include the bats, most birds, bees and wasps.

The following table indicating the environmental distribution of reptiles in the Turtle Mountain vicinity shows how sharply marked in

TABLE TO SHOW HABITAT LIMITATIONS OF AMPHIBIANS AND REPTILES IN THE TURTLE MOUNTAIN REGION

Species	Rocky hillside [*Encelia*]	Cañon bed [*Acacia*]	Rocky mesa	Wash bed [Palo verde and smoke tree]	Low plain (1000–2000 ft.) [Creosote bush]	High plain (2000–3000 ft.) [Tree yucca]	Drifting sand [*Ephedra*]	Cañon spring [Arrowweed]
	Environments with characteristic plants							
1. Bufo punctatus	....	....	....	....	....	....	....	×[4]
2. Testudo agassizii	×[2]	×[1]	....	....	....	××[7]	....	....
3. Dipsosaurus dorsalis	....	....	....	××[4]	×[2]	×[1]	×[2]	....
4. Uma notata	....	....	....	....	....	....	×[20]	....
5. Callisaurus ventralis ventralis	....	?	××	×	×	×	×[1]	....
6. Crotaphytus collaris baileyi	×	××	×[2]	....	....	....	....	....
7. Crotaphytus wislizenii	....	....	×	××	××	××	××	....
8. Sauromalus ater	×	××	×[1]	....	....	....	....	....
9. Uta stansburiana elegans	×	×	×	×	×	××	....	....
10. Uta graciosa	....	....	....	×[2]	×[2]	×[1]	××[4]	....
11. Sceloporus magister	×[2]	××	....	×[1]	?	?	....	....
12. Phrynosoma platyrhinos	....	....	×[1]	×[1]	××[3]	?	....	....
13. Xantusia vigilis	....	....	....	....	....	×[1]	....	....
14. Cnemidophorus tigris tigris	×	×	....	×	×	×	×	....
15. Sonora episcopa	×[1]	....	....	....	....	....	....	....
16. Sonora occipitalis	....	....	....	....	×[2]	....	?	....
17. Lampropeltis boylii	?	×[1]	....	....	....	....	....	?
18. Bascanion flagellum frenatum	×[2]	?	?	?	?	?	....	....
19. Crotalus cerastes	....	....	....	?	?	?	×[1]	....
20. Crotalus mitchellii	....	×[2]	?	×[1]	....	....	....	....

NOTE.—Large crosses mean abundant; two small crosses, fairly common; one small cross, rare. Small numbers opposite crosses refer to number of individuals upon which the generalization is based. A question mark (?) means that these species occur elsewhere on the desert in this environment and *may* do so in the Turtle Mountain region.

most cases are the habitat preferences of these easily observed animals. An occasional species, like *Uma notata* and *Xantusia vigilis*, is restricted entirely to one kind of habitat, and no species, even though abundant, is known to range into every type of environment, although there are no apparent physical reasons why it should not do so. Theoretically, therefore, it may be possible for isolation to occur in a very limited region of well differentiated habitats and associations. This suggests interesting problems concerned with habitat limitations (see Grinnell, 1914, p. 102), and the separation of species and genera within a faunal area. Of the eight genera of iguanine lizards here represented only three range much beyond the limits of the arid Southwest. All are closely related and belong to a single group within the sub-family. Many of the differences between these genera seem to be adaptive and to be correlated with the differences in the nature of their habitats.

CHECK-LIST OF THE SPECIES OF AMPHIBIANS AND REPTILES OF THE TURTLE MOUNTAIN REGION

Little uniformity prevails in the use of vernacular names for most reptiles. Nearly all our species have several book names, and others are burdened with appellations belonging to more than one species. The matter might well be put into the hands of a committee appointed to edit the names that have been used, and to decide upon suitable ones, if vernaculars are not to be dropped from the literature altogether. The common names employed in the following list have been selected for descriptive appropriateness or because of long use. The authorities here followed in the adoption of vernacular names are Ditmars (1907), Grinnell (1908), Grinnell and Grinnell (1907), Meek (1906), Merriam *in* Stejneger (1893), Stone (1911), Van Denburgh (1897), and Yarrow (1882). Whenever a descriptive name could be found it has been employed; in a few cases vernaculars in the following list have not been used before.

1. Bufo punctatus Baird and Girard. Spotted Toad
2. Testudo agassizii (Cooper). Desert Tortoise.
3. Dipsosaurus dorsalis (Baird and Girard). Desert Iguana.
4. Uma notata Baird. Ocellated Sand Lizard.
5. Callisaurus ventralis ventralis (Hallowell). Gridiron-tailed Lizard.
6. Crotaphytus collaris baileyi (Stejneger). Bailey Collared Lizard.
7. Crotaphytus wislizenii Baird and Girard. Leopard Lizard.

8. Sauromalus ater Duméril. Chuckwalla.
9. Uta stansburiana elegans Yarrow. Desert Brown-shouldered Lizard.
10. Uta graciosa (Hallowell). Long-tailed Swift.
11. Sceloporus magister Hallowell. Rough-scaled Lizard.
12. Phrynosoma platyrhinos Girard. Desert Horned-toad.
13. Xantusia vigilis Baird. Desert Night Lizard.
14. Cnemidophorus tigris tigris Baird and Girard. Desert Whip-tailed Lizard.
15. Sonora episcopa (Kennicott). Texas Ground Snake.
16. Sonora occipitalis (Hallowell). Desert Burrowing Snake.
17. Lampropeltis boylii (Baird and Girard). Boyle King Snake.
18. Baseanion flagellum frenatum Stejneger. Red Racer.
19. Crotalus mitchellii (Cope). Pallid Rattlesnake.
20. Crotalus cerastes Hallowell. Sidewinder.

GENERAL NOTES ON THE AMPHIBIANS AND REPTILES OF THE COLORADO DESERT

The most common amphibians of the Colorado Desert are toads. Three hardy species of *Salientia* (*Bufo cognatus cognatus, Bufo alvarius*, and *Bufo lentiginosus woodhousii*) inhabit the Colorado River valley, and one other species, *Bufo punctatus*, though not known to be found along the river (south of the Grand Cañon), occurs in some of the desert springs, mountain cañons, and stream-beds (see (Stone and Rehn, 1903, p. 34, and Stejneger, 1893, p. 219). The Great Basin leopard frog, *Rana pipiens brachycephala*, also lives in and along the Colorado River.

Recent reptiles are represented on the Colorado Desert in California and Arizona by one species of tortoise, one gecko (*Coleonyx*), one night lizard (*Xantusia*), the "Gila monster" (*Heloderma*), one teiid (*Cnemidophorus*) and thirteen iguanine lizards, one blind snake (*Rena*), six colubrine and two crotaline snakes. A mud turtle (*Kinosternon*) occurs along the lower Colorado River. It might be noted here that Stephens (1914, p. 134) denies reports of the presence of "Gila monsters" in southeastern California. Neither is there any authentic record of *Holbrookia* or *Elaps* from California. The iguanine lizards include nine genera, the colubrine snakes five, and the crotaline snakes two. Among the genera of iguanine lizards are found herbivorous, carnivorous, omnivorous, insectivorous and myrmecophagous forms. Most species of desert lizards live on the ground among rocks or on sand and some spend their time in bushes and desert trees. In comparison with the lizards, the snakes of the Colorado Desert are few in number of individuals.

Glancing over the characters which distinguish desert reptiles we find that great power of locomotion is possessed by all but a few of the forms. The latter include the rattlesnakes and "Gila monsters," which have special means of protection, and the chuckwalla, gecko and night lizard, which seem to be restricted to habitats where they find immediately accessible retreats. The desert whip-tailed lizard, the gridiron-tailed lizard, the desert iguana, the ocellated sand lizard and the red racer all live in the open and forage at great distances from cover. The leopard lizard, probably the greatest runner of all, preys on other swift saurians, and the Bailey collared lizard does likewise. The latter, however, lives among the rocks where cover is always quickly available, and its agility is doubtless associated with its carnivorous habits. In many of the swifter lizards the tail is held above the ground and used as a counter-balance while running.

Loose sand characterizes one of the typical desert habitats. Many remarkable adaptations in the desert reptiles are developed or preserved by this kind of an environment. In the burrowing snake, *Sonora occipitalis*, in the gridiron-tailed lizard, in the ocellated sand lizard, and in the desert horned-toad, the rostrum is specially developed, protruding beyond the mouth. These reptiles *swim* into the sand by lateral movements of the head, and the lizards mentioned do not employ the fore feet in digging as does the *Cnemidophorus*, or whip-tail group. The eyelids of the burrowing lizards are fringed and meet tightly along thickened edges and the nostrils are collapsible. In the sand-loving desert horned-toad the ear opening is usually covered by the granular integument, while in other species of the same genus it is not.

The toes on both front and hind feet of the most characteristic American sand lizard, *Uma notata*, are broadened by a fringe of elongate scales, and in this respect parallel certain species native to desert regions in other parts of the world.

Keen vision and alertness are attributes of most desert lizards. In *Dipsosaurus*, *Callisaurus*, and *Uma*, alert lizards inhabiting open plains with sparse vegetation, the head is held aloft and the body is propped up on the fore limbs when the creature gazes about (see pl. 22, fig. 7).

The tail-dropping faculty of the species of lizards here discussed varies from almost perfect autotomy in the night lizard to entire absence of this function in the chuckwalla. The latter uses its tail as an organ of defense. *Cnemidophorus*, *Uma*, *Callisaurus*, *Uta*, *Sceloporus*

porus, and *Dipsosaurus* are known to part with their tails, the first easily, the last with difficulty. In *Sauromalus*, *Crotaphytus* and *Phrynosoma* autotomy does not occur.

Notable in the case of many species, for example the desert horned-toad, the gridiron-tailed lizard, the ocellated sand lizard, and the side-winder, is the close resemblance between the color of the reptile as viewed at a little distance and the color of its surroundings (see Atsatt, 1913, p. 49; Stejneger, 1890, pp. 114–115; and Yarrow, 1875, p. 512). Color change in lizards may be seasonal, as in the orange-red nuptial colors of female *Uma*, *Callisaurus*, and *Crotaphytus wislizenii*, transitory, as the colors exhibited by the long-tailed swift when under excitement, or adaptive, as the dusky shades of gridiron-tailed lizards and horned-toads when found on dark soil (see in this connection Franklin, 1913, and Stejneger, 1890).

The femoral pores in lizards secrete a substance which seems to be of use during the breeding season. In many desert reptiles the period of greatest sexual activity, from April to July, is accompanied in the male by an abundance of the waxy secretion of these glands. Lizards in which a decided difference was found at this time of year between the size of the femoral pores in males and females were the chuckwalla, the rough-scaled lizard, the gridiron-tailed lizard, the long-tailed swift, the Bailey collared lizard, the ocellated sand lizard, and the desert whip-tail. The pores function most actively therefore in adult males during the early summer.

The daily and seasonal habits of desert reptiles seem to show some correlation with the distribution of the species. Those forms like *Dipsosaurus dorsalis*, *Uma notata*, *Sauromalus ater*, *Uta graciosa*, and *Crotalus cerastes*, which have ranges restricted to the hottest parts of the desert, may be seen abroad at all hours of the day during the summer and scarcely ever appear in the winter. *Uta stansburiana*, which is the only desert lizard ranging into the cooler Pacific coast district, is the last to be driven into cover by the cool of winter and the first to emerge on warm days.

It is reasonably certain that most, if not all, of the American desert reptiles do not require water.

ANNOTATED LIST OF THE AMPHIBIANS AND REPTILES

Bufo punctatus Baird and Girard

Spotted Toad

Forty-three larvae and recently metamorphosed young of a species of toad (no. 5539) are at hand from North Mountain Spring. I have available no comparable young of *punctatus* and so cannot be quite certain of the above identification of these young specimens. They are about half the length of *Bufo halophilus* of corresponding stage of development; they are broad-headed and dotted on the back with many small tubercles (red, in life) surrounded with indistinct black circles. The underparts are white and gray in alcohol (bronze-colored beneath, in life). The lower labial teeth in the tadpoles are in two long rows and one short one. The first of these (anterior), in the specimens examined, contained 126 teeth, the second 120, and the third 31 teeth. The comb-like upper lip is made up of from 55 to 65 solidly united teeth, and the lower lip of from 78 to 95 teeth (in three specimens examined). Total lengths, in millimeters, of nearly grown tadpoles: 25.4, 24.5, 23.0, 25.0, 25.0. Total lengths of recently metamorphosed young: 10.3, 9.7, 10.2, 10.5, 9.4.

The tadpoles were found on May 28 in a water-hole at the south end of the Turtle Mountains, five miles from any other spring and thirty miles from the nearest permanent stream. A search revealed some young toads huddled together in the crevices of planks about the pool, and some in wet sand nearby. The toads were active and apparently well fed, having an abundance of small flies to prey upon about the foul water. The sluggish tadpoles, swimming slowly to the surface of the murky, red pool were easily taken in the hand.

The sporadic occurrence of this amphibian in the driest of North American deserts is noteworthy.

Testudo agassizii (Cooper)

Desert Tortoise

Four tortoises were collected on July 20, 1909, at Goffs. None was seen at the south end of the Turtle Mountains, though their dens and broken skeletons were found there.

A large living specimen was obtained in 1908 at Mecca, Riverside County, California. It was said to have been taken in the Cottonwood

Mountains twelve miles northeast of the locality mentioned. This specimen was measured on February 23, 1909, and again on May 21, 1912. It was thirteen inches in length and had grown scarcely at all during these three years. It differed from the examples taken at Goffs in the color of the iris, which was yellow rather than brown as in the more northern examples. A desert tortoise was found near Victorville in April, 1906, and another at Barstow on March 16, 1914. In the Museum are additional specimens (nos. 3550 and 3609) from Kramer, San Bernardino County, and one-half mile east of Mohave, Kern County, California. A dead tortoise was seen three miles south of Palmdale, Los Angeles County, California, on July 24, 1914. Tortoises, though widely distributed, appear to be common at few places in the desert.

From what has been published concerning *Testudo polyphemus* of the southern states, a close relative of the desert tortoise, it appears that the most western North American species and the gopher tortoise of the East do not differ much in their general habits. Both live for the greater part of their lives in holes, both inhabit sandy or other loose soil suitable for the burrowing of their dens, and both dig their own refuges by the crude methods at their command. Like all known members of the genus, both are herbivorous.

About a mile north of Goffs station a number of desert tortoise burrows were found, some of which were occupied. The holes were dug slantingly into the rather firmly packed sand and gravel, usually at a grade of about forty-five degrees. Often the places chosen were under creosote bushes and in the banks of small dry washes. The tunnels were from two to eight feet long, with a slight widening at the bottom. They varied in diameter with the size of the tortoise that inhabited them, being in every case about the shape of a longitudinal, vertical section of the animal's shell. Sometimes the tortoise could be seen lying at the inner end of its burrow. In the deeper holes a stick thrust in would reveal the presence of the creature which, lying partly outstretched, would draw up its feet and head when it felt the touch; and this diminution of respiratory space beneath the shell would be accompanied by a noisy expiration like the rapid blowing of a bellows. When seized by the back of the carapace to be drawn out the tortoises would sometimes stick fast in the holes, hooking their crooked front legs into the sand. One deep burrow, otherwise empty, contained the broken halves of two white, hard-shelled eggs which appeared to have been spherical and about an inch in diameter. No brush or food of

any kind was found in any of the dens. Late in the afternoon of a hot July day a large tortoise was surprised in the act of coming out of its burrow. When it saw me it turned immediately and ambled back to safety.

Desert tortoises are said to come out in great numbers after thundershowers. But this is by no means the only time of their activity, for they appear to wander abroad at all seasons, frequenting rocky and uneven as well as level ground. One meets with them plodding steadily across-country, occasionally stretching their short necks down over the pointed extremities of the plastron and testing the ground with the sensitive tip of the snout or stepping aside to crop some small annual plant growing in the shade of a boulder. Their usual gait does not carry them along at a rate of more than four or five miles a day (twenty feet a minute by test), and they live at such great distances from water that in places it would seem impracticable for them to get a drink from one year's end to another. Sometimes when roughly handled a tortoise will void the contents of its cloaca and bladder. The faeces are black and about the size of those of the fox.

The author kept a number of desert tortoises at his home for a time in an enclosure out-of-doors. The captive tortoises paced their pens and frequently attempted to dig out under the fence. They were not able to burrow into hard ground, but in a gravel bank they would scrape away alternately with the fore limbs and when the hole became deep enough would turn around and push the dirt out with their shoulders. They grazed contentedly upon the lawn or in patches of green weeds, and also ate lettuce or cabbage leaves thrown to them. They were never active unless warm and seldom so even then, coming out in bright sunshine to lie outstretched or seeking the warmth of a stove or radiator in a room. They were handled a great deal and were never known to open their mouths to bite. They soon became used to human surroundings and would pursue their accustomed activities with people about. Some of their habits are worthy of notice.

When one tortoise meets another in the course of its journeying each, whatever the sex, nods its head rapidly up and down as if in salutation, and sometimes noses are touched before passing along. If two males happen to meet, a fight is likely to ensue. After the preliminary nodding the tortoises separate a little distance and then rush toward one another with the heads drawn part way into the shell. The combatants meet head on and the curved horns projecting from the anterior end of the plastron are butted rather violently against the

adversary, but do him no damage except sometimes to turn him upon his back; he may then struggle for some time with one fore leg vibrating vigorously in the air and the other pawing for a foothold in the ground before he can right himself.

The males court their mates by biting them gently around the edges of the shell. During copulation the male stamps his hind feet and utters a mechanical grunt with the head hooked over the end of the plastron and the mouth half open.

Stephens (1914, p. 135) writes that teeth marks are sometimes seen on shells of living tortoises and believes that the shells "generally prove too hard for the coyotes." The younger tortoises are soft-shelled and delicate. They probably fall prey in numbers to raptorial mammals and birds. The old ones are a favorite delicacy among Indian and Mexican section-hands who live with their families along the railroad lines. Some tortoises kept as curiosities at Needles on a grass plot in front of the Santa Fe hotel are thought to have been gradually depleted by the inroads of the Indians, many of whom lounge about the place.

Dipsosaurus dorsalis Baird and Girard

Desert Iguana

Four desert iguanas (nos. 5499–5502) were taken in the vicinity of Blythe Junction. In two specimens the rostral plate is separated from the nasals by one row of scales, and in the other two individuals by two rows. The femoral pores are 18 in two thighs, 21 in four, and 22 in one; being 18 right : 18 left once, 21 :21 twice, and —:22 once.

The ground color varies slightly from light grayish to yellowish. One specimen has wide, brown reticulations enclosing lighter spots on the sides and back. A smaller example has narrow brown dots and dashes in place of the broad reticulations.

The total length of the largest individual is 360 millimeters; the tail is partly regenerated and measures 242 millimeters.

These round-nosed, large-tailed lizards are fairly common in the low plain environment in the sandy tracts south of Blythe Junction, and in the washes traversing the alluvial slopes about the Turtle Mountains. They appear to avoid rocky ground, being absent from the hillsides and mesas. They are shy when approached and run swiftly, with tail slightly raised, to the shelter of a bush, or into a chipmunk's or kangaroo-rat's burrow. When wounded they puff themselves up till

their sides become taut, and may then be pulled from a small hole only with difficulty. With curiosity aroused they prop themselves high on their fore limbs, attentively viewing the passer-by and seldom "showing off" with up-and-down movements of the body.

These lizards are phytophagous and may be sometimes surprised in the act of raiding the young leaves of low bushes, in the upper foliage of which they forage during the hottest part of the day. The stomach of a medium-sized individual contained two grams of the leaves and fruit of a malvaceous annual, *Sphaeralcea ambigua*.

Remains of a desert iguana were found below the cliff-side nest of a prairie falcon where, on June 6, 1914, two nearly grown young falcons set up a squawking chorus at my approach.

Uma notata Baird

Ocellated Sand Lizard

In the drifting sand two miles south of Blythe Junction, thirteen specimens of this extraordinary species were obtained (nos. 5444–5456). Some have the identical characters ascribed only to *Uma rufopunctata* by Cope (1900, pp. 279–281), while the smallest specimens are referable to *Uma notata* as described by Cope (1900, pp. 277–279) and Baird. It seems almost certain that the separation indicated is based on nothing more than individual and age differences. It appears also likely that the other two described species of this genus are but extreme variations of *notata*. Both *scoparia* and *inornata* were described from localities which lie within the probable range of *notata*, and in each case the type is the only known example. Three specimens at hand from Imperial County, California (doubtless near the type locality of *inornata*), have distinct spots on the belly and are not different from individuals in the Blythe Junction series. Most of the characters supposedly distinctive of *scoparia*, including the diamond-shaped dorsal scales and black dorsal spots, are expressed in individuals of the present series. The increased number of femoral pores in the type specimen of *scoparia* finds a parallel in individuals of other species of lizards and is probably also in this case not to be considered of systematic importance.

The femoral pores (including the accessory row) in the series collected near Blythe Junction number 25 in one thigh, 27 in one, 28 in one, 29 in three, 30 in four, 31 in four, 32 in four, 33 in one, 34 in four, and 35 in two; being ♂ 35 right: 35 left once, ♀ 34:34, ♀ 34:29,

♂ 33:31, ♂ 32:32, ♂, ♀ 31:32 twice, ♀ 30:34, ♂ 30:30, ♀ 29:31, ♀ 29:30, ♀ 27:28, and ♀ —:25. They are small in the eight females and medium-sized in the five males of the lot. In six cases they are in one and in seven instances in two rows. An accessory row is not present in the thighs with 25, 27, 28 and 35 pores, but is represented in most of the intermediate thighs and contains from one to three pores.

The supra-ocular rows of scales are 8 in one individual, 9 in five, 10 in five, 11 in one, and 12 in one. The loreal rows, counted where they join the line of the orbit, are 7 in six and 8 in seven specimens. The labials are strongly keeled; they number $\frac{7}{14}$ in one, $\frac{8}{13}$ in two, $\frac{8}{14}$ in one, $\frac{8}{15}$ in two, $\frac{9}{15}$ in two, $\frac{9}{16}$ in two, $\frac{10}{14}$ in two, and $\frac{10}{15}$ in one. The keeled suborbitals are 6–6 in one, 6–5 in two, 5–5 in four, 5–4 in one, 4–4 in two, 3–4 in one and 3–3 in one. The occipitals are separated from the small supra-oculars by 3 to 4 rows of scales. The scales on the outer edge of the gular fold are smaller than those in the middle, which in turn are larger than those on the throat. Ear lappets are 4 to 6. The points on the fringes of the lower eyelids are longer than those on the upper.

In all the specimens of the present lot a black spot from four to twelve millimeters in diameter is present on each side of the abdomen (see pl. 22); in some of the smaller specimens these spots are narrowly margined with green. In three the black markings on the throat are indistinct or reduced; in others two or three crescents and one to three V-shaped marks are present on the throat (see pl. 22, fig. 6). The black spots on the tail number 0 to 7; they are apparently not present on regenerated tail-tips and are never continued on the dorsal surface as in *Callisaurus*. Four of the smaller specimens are dorsally of the greenish *notata* type of coloration, with the ground color of the back of a pale greenish blue, near pale glaucous blue. Five of the intermediate examples are spotted with cinnamon on a background of greenish yellow, with the ocellations and brown crescents ascribed to *rufo-punctata;* and the four largest individuals (all males) are of the *scoparia* type of coloration, being covered with rich black ocellations each bordered with a fine line, one scale wide, of orange-rufous. Each spot of light color is centered with a black dot, itself encircled by a narrow orange-rufous ring. The ground color is maize yellow. The eyelids and sometimes the sides of the head and tail in females are tinged with orange. One so colored contained three eggs, each 9 millimeters in diameter. Another contained one egg 18 millimeters long. Black spots are present behind both femurs in only two indi-

viduals and behind one femur in three; they are in all cases very small and obscure.

Measurements in Millimeters of *Uma notata* from Near Blythe Junction, Riverside County, California

Sex and number	5445 ♂	5452 ♀	5450 ♂	5449 ♀	5456 ♂	5454 ♀	5451 ♂	5453 ♀
Total length	215	181	193	172	201	180	202	139
Tail length	112	94	96	90	108	94	98	69
Body length	103	76	97	82	93	86	104	70
Hind foot	31	27	30	27	32	27	32	26
Base of 5th to end of 4th toe	27	23	26	22	27	24	27	20
Snout to ear	19	18	19	18	19	18	18	15
Head width	16	15	17	15	17	15	18	12

The ocellated sand lizard has so far been taken only at a few localities within a circumscribed area on the deserts of the southwest. It is strictly confined to belts of wind-blown sand, and in the vicinity of Blythe Junction was never seen beyond the borders of a narrow zone of sand dunes two miles south of the railroad. Many of these shy lizards were abroad in the hotter part of the day, scurrying over the fine sand, with a cloud of dust in their wake, or foraging beneath squaw-tea bushes on the dunes. Seldom was an individual taken unawares, and it was found difficult in most cases to approach an alert animal close enough for a successful shot with the .32 caliber auxilliary. Plate 22, figure 7, from an animal in captivity, shows the posture when fully alert.

The speed attained by these heavy lizards on loose sand is not so great as that of *Crotaphytus*, *Cnemidophorus* and *Callisaurus* in the same situations, despite the broadening fringe of scales on the toes. When alarmed they make for the nearest dune and turn behind it to enter a *Dipodomys* or *Citellus* hole or to bury themselves quickly in sand as the gridiron-tails do, the broad nose of which lizards their own shovel-like snout resembles. The tracks of the hind feet of a *Uma* running at top speed are five to six inches apart; and the deep imprints of these members indicate that most of the work is done by the hind legs, the fore limbs being merely used to balance the creature. The tail is curled upward while running, as in *Callisaurus*.

Their curious color patterns, though they may seem unduly striking when viewed in the specimen in hand, really harmonize in strong light with the buff tint of the sands, and the lizards are seldom detected until they begin to move.

One stomach was filled with a great number of ants. Another contained two grasshoppers entire, one large hemipter, eight red ants, two brown ants, two beetles, a pebble, and several pieces of vegetation. Another held seven brown and seven red ants, one beetle, several parasitic nematodes, and two fresh leaves and the terminal bud of a plant. One specimen when shot had a plant stem in its mouth.

Callisaurus ventralis ventralis (Hallowell)

Gridiron-tailed Lizard

Eighteen specimens of this abundant lizard were shot (nos. 5457–5474). All have four dark patches on the belly, two on each side, and are in other ways typical. The femoral pores are 12 in one thigh, 13 in one, 14 in four, 15 in six, 16 in six, 17 in eight, 18 in five, and 19 in three; being ♂, ♀ 19 right 18 left twice, ♀ 18:18 once, ♂ 17:19, ♂ 17:18, ♂ 17:16, ♂ 17:15, ♂ 16:17 twice, ♂ 16:16, ♀ 16:14, ♂ 15:17, ♂, ♀ 15:14 twice, ♂ 14:15, ♀ 13:15, ♂ 12:15 and ♂ —:17. Among the thirteen males five have large femoral pores, six have medium-sized ones, and two have small ones. All the five females have small pores. The males have large postanal scales, the females small ones.

In the examples before me the color above grades from pale smoke gray, with white on top of the head and white in spots down the back, to neutral gray with the usual dark dorsal markings. A specimen taken in the zone of drifting sand below Blythe Junction is the lightest of the lot, and some taken upon a mesa covered with brown lava are among the darkest of the specimens represented. It would appear that in this lizard, as in *Phrynosoma*, the tone of color is changeable in the individual to suit the surroundings. The throat is dusky in some specimens and light in others. There is a reddish spot behind the arm in the females. The females also all have pink sacs beneath the throat which are not "inflated," but are sometimes drawn down by muscles connected with the hyoid apparatus. The pink throat sacs are present in only three of the males in the series at hand. The underparts (with the exception of the two black wedges and the blue and green patches of the males) are white and not yellow as in specimens taken at Barstow, farther west. The tail bands number 4 in one, 6 in three, 7 in three, and 8 in eleven specimens. The anterior three or four of the ventral tail spots are sometimes entirely blue, and the posterior bands are often margined with blue below. Several of the largest males are nearly equal in length, but do not approach in size, individuals collected at Barstow in March, 1914. In the largest speci-

men from Blythe Junction (no. 5472), the total length is 194 mm., tail length 111 mm. A specimen from Barstow, San Bernardino County (no. 5385), is 223 mm. in total length, and 130 mm. in length of tail.

This lizard is abundant on the open desert around the Turtle Mountains. It does not occur on the rocky hillsides, and even in the sandy cañon bottoms is found but sparingly. It is on the open stretches of desert dotted with creosote bushes that this species is typically at home; and here it outnumbers all the other diurnal vertebrates combined. Individuals may be observed bobbing up and down, switching the tail from side to side, walking jerkily along with the tail curled over the back, or running with such speed that the eye can barely follow. The writer estimated that one of these swift lizards covered a distance of 90 feet in four seconds, which would be travelling at a rate of about fifteen miles an hour. The lizards can stop and start with the most confusing abruptness, and rarely run straight away but describe a circle when pursued. When tired out they may crouch close to the ground and will then permit themselves to be caught; or they may burrow into loose sand by wriggling the head from side to side and pushing with the hind feet while the front feet remain pressed close to the side. Sometimes when closely pursued they enter holes.

Of eight stomachs examined not one contained plant remains, the contents being insects, small pebbles, part of a shed lizard skin, and parasitic nematode worms. Perhaps, like some of the geckos, these lizards eat their own shed integument. The insects represented included eight Orthoptera, eight ants, and several small Coleoptera. Some of the grasshoppers and crickets were of large size (40 mm. long) and had been swallowed entire. These lizards sometimes spring a foot or more to seize a tempting bait; and I saw one, probably by mistake, leap over the edge of an eight-foot wash-bank while jumping for a grasshopper in a bush. At Blythe Junction a gridiron-tailed lizard was seen regularly at a certain doorstep picking up dead crane-flies and other night-flying insects thrown there by the housewife. The lizard apparently became so absorbed in picking up, shaking and swallowing the gauzy-winged flies that it many times permitted the observers to touch it lightly upon the back.

After sundown the gridiron-tail buries itself in sand, and when alarmed as by an approaching team or pedestrian will start up suddenly and dash away.

Some of the females taken in July contained eggs. Two eggs, 18 by 9 millimeters in the two diameters, were taken from one lizard; these had coriaceous coverings and were apparently ready to be laid.

Crotaphytus collaris baileyi Stejneger

Bailey Collared Lizard

Eight specimens (nos. 5480–5487) represent this form in the collection from the Turtle Mountain region. There are five males and three females, the former being readily distinguished by the large postanal plates. All have the interorbital scales in two distinct rows.

The femoral pores are 16 in three thighs, 17 in five, 19 in four, 20 in two and 21 in two; being ♀ 21 right: 21 left once, ♀ 20:20, ♂, ♀ 19:19 twice, ♂ 17:17 twice, ♂ 16:17, and ♂ 16:16. They are very small in the three females, medium-sized in three males, and large in two of the males. Stejneger (1890, p. 105) describes the color of a living Bailey collared lizard from the San Francisco Mountain plateau, Arizona. None of our specimens show strongly marked reticulations as do examples from farther east and north. All the females have faint indications of whitish cross-bars, and in them the black collar is not joined below the neck. The males have the collar connected ventrally, and the largest males show not a sign of dorsal cross-bars. The total length of the largest specimen, a male, is 310 millimeters, the tail length 214 millimeters.

These grotesque lizards inhabit the rocky slopes of the Turtle Mountains in numbers and live also among the rocks about the bases of the hills, but they were never seen on the open desert. This agrees with observations by Taylor (1912, p. 326) in northern Nevada. Like the chuckwallas, the Bailey lizards mount rocky eminences and lie for hours in the sun during the hottest part of the day. When approached they slip down into crevices or run with alacrity over the roughest ground, clearing obstacles up to two feet in height with great leaps. The males distend their dark throats when "showing off." They seem hard to kill, and when thought dead will sometimes "come to life" in the collecting sack, blinking their yellow eyes and looking ferocious. When under excitement the brilliantly colored throat is distended and the huge mouth is sometimes opened in anger. Cones (1875, pp. 598–599) has recorded interesting observations upon the habits of this species.

One stomach contained two chewed grasshoppers, and another three orthopterous insects, more or less chewed, and four small beetles.

Crotaphytus wislizenii Baird and Girard
Leopard Lizard

Six specimens of this species were secured (nos. 5488–5493) of which two are females and four males, the latter with large postanal scales. The femoral pores number 20 in one thigh, 22 in one, 23 in three, 24 in four, and 25 in three; being ♂ 25 right: 25 left once, ♂ 25:23, ♀ 24:24, ♂, ♀ 23:24 twice, ♂ 20:22. One of the females taken in July still displays the red nuptial coloration: the bars on sides of neck, back and hind legs (in ordinary coloration white or yellow) are peach red to scarlet; base and tip of tail beneath are shrimp pink. The ground color of this individual is light neutral gray on the lighter parts of the back; fuscous spots occur on the back and sides, with bands of the same color on the tail. A female (no. 5489) not exhibiting red coloration contained one large egg. A large male has scarcely a trace of the ordinary reticulation on the back, and the brown dorsal spots are reduced to small dots on the body and tail. The longest specimen, a male, has the following measurements: total length 364 millimeters, tail length 260 millimeters.

The leopard lizard, probably the swiftest of North American desert reptiles, was fairly common in the Turtle Mountain district at the time I was there. This species does not inhabit the rocky hillsides in that vicinity; unlike the Bailey collared lizard, it appears to haunt the more level plains and sandy places. Individuals are wary and take to retreats, often before it is possible to get a shot at them. The tracks of the hind feet of leopard lizards running swiftly in sand were found to be ten inches apart.

A grown gridiron-tailed lizard swallowed whole and head first was found in one stomach. The flabby sides of the leopard lizard are often distended with the remains of smaller lizards which they have run down and swallowed. Taylor (1912, p. 348) and Franklin (1914) have seen this species eat cicadas, leaping into the air to catch them.

Sauromalus ater Duméril
Chuckwalla

Chuckwallas were common on the rocky sides of gulches at the Horn Mine. Seven specimens were taken there, and one specimen in a level field of scoriae at Blythe Junction. These specimens (nos. 5518–5525) show considerable individual variation in width of head,

size of scales on side of neck, and coloration, but fall easily within the general range of characters given for this species. The femoral pores are much enlarged in the males and almost indistinguishable in the female, a condition holding in many other species of lizards of the locality in the early summer season when collecting was done. The femoral pores number 15 in one thigh, 16 in three, 17 in one, 18 in three, 20 in two, 23 in one, and 24 in one of the thighs, where counts could be made; being ♂ 23 right: 24 left, ♂ 20:20, ♂ 18:19, ♂ 18:16, ♂ —:18, ♂ 16:17, ♂ 15:16, ♀ —:—. One individual exhibits an accessory row of pores on each side.

Some of the specimens show a great amount of red on both dorsal and ventral surfaces and a few do not; some are banded on the tail and some exhibit scarcely a trace of this characteristic. In a young specimen there are around the tail four broad, encircling bands of brown alternating with three circles of yellow. An adult male (no. 5520) is colored as follows: top of head dark brown, nearly black, with many yellow scales scattered over the occiput and head and small patches of orange in the ear just behind the tympanum; back speckled with black scales in lichen-like pattern; about an equal number of orange and of yellow scales, evenly dispersed, covering most of back; shoulder patches large, dark brown, and dorsal surfaces of limbs dark brown; feet spotted with yellow; head and limbs beneath, black; belly almost uniform dark morocco to brick red; tail abruptly lighter than rest of body, deep colonial buff, faintly banded with three broad rings of deep olive buff. The measurements of the largest male are: total length 371 millimeters, tail length 198 millimeters.

This clumsy, vegetarian lizard is common on the rocky slopes of the Turtle Mountains and may occasionally be seen in the patches of scoriae out from the base of the range. It was never noticed elsewhere, and having rather feeble powers of locomotion, doubtless depends upon the security of the rocks to a greater extent than do swifter lizards. It lacks the curiosity of smaller species and loses no time in slipping to safety at the approach of danger.

Chuckwallas were seen perching on rocks so hot as to be unbearable to the hand, and big, gorgeously colored males were noted in pursuit of each other over hillsides in the middle of the hottest July days. In the latter part of June one pair, male and female, were seen near one another.

The chuckwalla has a curious habit of sticking out the fleshy tongue at every few steps when walking along. Like toads and

Phrynosoma, Sauromalus can be made to assume a rigid hypnotic posture by gentle rubbing on the belly. In this condition an individual may remain half an hour without moving.

The half-eaten body of a large female was picked up near a nest containing two young prairie falcons. When attacked in its retreats, the chuckwalla inflates itself and lashes the heavy stub-tail about vigorously. Aside from this it appears to be utterly innocuous, and the writer has never known one to attempt to bite even when handled roughly. Mr. Dane Coolidge states that the desert Indians, to whom the chuckwallas are a delicacy, puncture the lizards' sides with sharpened wire in order to deflate them and then draw them from their retreats among the rocks.

Old chuckwallas often have scars on the back caused perhaps by crawling about in crevices. One individual secured had lost the front foot on one side and the hind foot on the other, and in spite of its misfortune was lively and had a stomach full of food. One chuckwalla was seen up in a small creosote bush from which most of the leaves had been stripped. The three stomachs examined contained plant remains. In two cases the leaves were swallowed entire and belonged to a composite (*Franseria dumosa*) and a spurge (*Euphorbia polycarpa*); the other stomach contained many chewed leaves and stems.

Uta stansburiana elegans Yarrow

Desert Brown-shouldered Lizard

The present writer follows Richardson (1915, p. 473) in the use of the above name. The characters ascribed to *elegans* are exemplified fairly well in the nine specimens (nos. 1099–1100, 5526–5532) from the vicinity of the Turtle Mountains. The dorsal horizontal scale rows number 76 in two specimens, 82 in two, 84 in one, 85 in two, 86 in one, and 100 in one. The average number of rows is 84, and the error of numbering, as ascertained by repeated counts, is certainly not greater than 7 per cent. The average number of dorsal scale rows in six specimens of *hesperis* at hand is 100.6. These averages agree quite well with determinations by Richardson of 86.5 and 102 for the two subspecies *elegans* and *hesperis* respectively. Individuals of the two subspecies cannot always be separated by the number of dorsal scale rows alone. The present series of *elegans* is much bluer in dorsal coloration and smaller in size than in the large series of *hesperis* at hand. The femoral pores number 13 in three thighs, 14 in ten, and 15 in

four; being 15 right: 15 left once, 14:15 twice, 14:14 three times, 14:13, —:14, and 13:13. All have scattered bright blue scales over the back, and some are green along the sides. In one female the indigo patches in the axilla are almost entirely lacking. Both striped and spotted types of coloration are exhibited in the present series. The total length of the largest example, a female, is 139 millimeters, and the tail length is 89 millimeters.

The tiny desert brown-shouldered lizard occurs throughout all the environments of the Turtle Mountains district except in the tracts of eolian sand near Blythe Junction. It seems to be most common in the more rocky localities, particularly on the lava fields. Those taken on brown scoriae were noticeably bluer than those found elsewhere. The stomach of one individual contained several small ants and beetles, and one spider.

Uta graciosa (Hallowell)

Long-tailed Swift

Seven specimens of this arboreal lizard were collected (nos. 1102, 5533–5538), one at Goffs and six near Blythe Junction. These include five males and two females. All the males have large postanal plates and blue patches on the belly. The females do not possess either of these characters. The scutellation of the back in the present series is typical. The femoral pores number 10 in three thighs, and 11 in nine; being ♀, ♂, ♂, 11 right: 11 left three times, ♂, ♀ 11:— twice, ♂ 11:10, ♂ 10:10. The pores are large in the males only. The colors are rapidly changeable in life, as described below. A male in alcohol has the patches on the belly olympic blue in color, thickly flecked with white, and divided by a light line. Each white dot involves one scale. The sides are yellowish, and the back grayish with reticulations of dark gull gray. The alcoholic females are yellowish beneath. The largest specimen, a male, measures 181 millimeters in total length and 127 millimeters in tail length. A female measures in total length 168 millimeters and in tail length 114 millimeters.

A number of long-tailed swifts were seen in the vicinity of Blythe Junction. Some were in creosote bushes on the open desert, some in squaw-tea on the sand dunes, and some on the branches of smoke trees in the washes. They like to sun themselves on the topmost twig of a bush, hanging motionless and head downwards as though pinned there by a shrike. If disturbed they drop to the middle of the bush and

flatten themselves against a limb lengthwise, keeping on the side away from the intruder, their wiry tails stretched out stiffly in line with the body. When alarmed while on the ground they make for the nearest bush and jump up into it, there to dodge actively about among the branches, quite unlike their brown-shouldered relatives which usually retreat beneath stones or into holes when pursued. The species under discussion appears to be active at least till dark in the evening, and early in the morning, as well as in the middle of the day.

A pair was seen copulating on July 13, in the hottest time of the day. The two lizards were clinging to the inclined branch of a creosote bush and the female was colored for the occasion, being light orange with two longitudinal black stripes down the sides and a row of black lozenges down the center of the back. The male was grayish over the back and yellowish on the sides. The power of color change in these lizards is greater and more rapid than in any other Californian reptile. A nearly white male held in my hand changed rapidly in two or three minutes to yellowish with black cross bands on the back, the originally light greenish ventral patches became blue, and a yellow spot appeared under the throat.

I saw a female of this species swallow a large-winged insect it had picked up from the sand. The stomach of a male contained chewed plant stems and what appeared to be the broken shells of insect eggs. An elongate, white, tick-like parasite was seen affixed head downwards in the axilla of a long-tailed swift.

Sceloporus magister Hallowell

Rough-scaled Lizard

Five specimens (nos. 5475–5479) of this brilliantly colored lizard were taken. Four are males and one is a female. The femoral pores number 13 in five thighs, 14 in two, and 15 in three; being ♀ 15 right: 15 left once, ♂ 15:14, ♂ 14:13, ♂ 13:13 twice. The pores are small in the female and greatly enlarged in the males. The anterior auricular denticulations are long and tapering.

The coloration of the adult males varies a good deal, and this variation is especially noticeable in the vivid ventral colors. One male has the neck band pure black, the throat patch olympic blue of the sheen of porcelain, the darkest belly scales urania blue of a porcelain cast, and the scales laterally on the ventral patch variscite green to Blanc's blue. Many of the scales along the sides of the body are edged with

rufous and have brown centers. Scales on the sides of the tail are opaline green. The general color of the upper parts and the top of the head is deep olive buff to buffy brown. The scales of the dorsal surface are edged with dark brown. The ground color of the ventral surface is whitish.

The ventral patches are in three specimens divided and in one united. There are no indications of dorsal cross bands or spotting in any of the males. The female is marked dorsally with sixteen brown patches, about a scale in width. The lower surface is creamy white lightly tinted on scattered scales with pale greenish, pale orange and, beneath the throat, pale blue. The collar of the female is brown.

The largest male measures 266 millimeters and the tail length in the same specimen is 149 millimeters.

The rough-scaled lizard was only occasionally seen in the Turtle Mountain region. It lives in and beneath catclaw bushes, on boulders in the cañon bottoms, and in caves in the undercut wash-banks. In only one instance were any of these lizards noticed far from safe retreats. During the forenoon of June 2, while the ground was still damp from a recent thunderstorm, two large male rough-scaled lizards appeared at intervals on a bare hillside. An explanation of their unwonted fearlessness may have been that they were in an active sexual state.

A large orthopterous insect, somewhat chewed, a fly, a beetle, and several other insects were found in one stomach. Another stomach contained a grasshopper, a beetle, a lepidopterous insect, several small red ants, and some pebbles. A third contained a caterpillar, five Coleoptera, one hemipter, three small red ants, the fruit and green leaves of a small plant (identity uncertain) and a few dry leaves (perhaps taken accidentally).

Phrynosoma platyrhinos Girard

Desert Horned-toad

Five specimens of this species (nos. 5494–5498) were collected, including two females and three males; and these were all the horned-toads seen in the Turtle Mountain vicinity. The males can be distinguished at once by the large postanal plates. The ear opening is covered in all the above specimens. The femoral pores number 7 in three thighs, 8 in five and 9 in two; being ♂ 9 right : 8 left once, ♀ 8:9, ♂ 8:8, ♂ 7:8, ♀ 7:7. The red of the dorsal parts varies much among in-

dividuals, being light coral red in some and brick red in one, which latter also has the sides of the head, the horns, and the tail sprinkled with light red. The underparts are pure white, or else spotted with from 60 to 70 black dots. Red in the dorsal coloration occurs in both males and females. The total length of the longest specimen, a male, is 137 millimeters, and the tail length is 52 millimeters. Another male measures 122 millimeters in total length and has a tail length of 48 millimeters.

Desert horned-toads about the Turtle Mountains are occasionally seen in the sandy wash-bed and low-plain environments. They seem to be less frequent on the rocky mesas, and are wholly absent on the hillsides. Their activity in the hot season appears to be restricted to the morning and afternoon hours. When alarmed they often retreat to the shelter of an *Atriplex* or other low-growing bush, dodging about, when pursued, on the ground beneath the thickly matted lower branches (see Richardson, 1915, p. 423). One was found on an open mesa after sunset, appressed to a small brown piece of lava and apparently asleep. This individual was dark gray when discovered, but became very light in color the next day.

Phrynosoma platyrhinos seems to be a more agile species than *P. blainvillii* of the Pacific coast district in southern California. Bryant (1911, p. 16) interestingly describes the burrowing habits of *Phrynosoma*.

The examination of the stomach of a preserved specimen revealed four parasitic nematodes, six beetles, one orthopter, many black ants, a leaf, a seed, five pebbles and some gravel and earth. Contents of another stomach were: fifteen parasitic nematodes, six Coleoptera, one orthopter, 145 red-headed ants, all apparently of the same species and swallowed whole, and one pebble.

Xantusia vigilis Baird

Desert Night Lizard

The only specimen found (no. 1101) was taken near Goffs. It has 116 transverse and 38 longitudinal scale rows on the back. The frontonasals are joined on the median line, the frontal is entire, and the specimen seems identical with examples of *vigilis* from the western Mohave Desert. There are seven femoral pores on the right thigh. The color above is cream buff to chamois; slightly lighter below; faint

white lines on back of neck; back speckled with brown scales. Total length 86 millimeters, tail length 52 millimeters.

The specimen secured was found in the usual habitat of the species, under a prostrate tree-yucca branch in a small grove of *Yucca mohavensis*. The species is rare in this locality, which appears to be the eastern limit of its range. Unsuccessful search was made for night lizards among the rather scattering tree yuccas along the east base of the Turtle Mountains, five miles north of the Horn Mine.

Cnemidophorus tigris tigris Baird and Girard

Desert Whip-tailed Lizard

Fifteen individuals (nos. 5503–5517) of this forked-tongued lizard were secured in the vicinity of the Horn Mine and Blythe Junction. This series illustrates some phases of variation as pointed out by Gadow (1906) for this remarkably unstable genus. The scales along the edge of the gular fold are all smaller than those under the chin, and are of equal size throughout. The number of large, transverse scales in front of the forearm run from 6 to 9. The femoral pores are 19 in one thigh, 20 in five, 21 in six, 22 in nine, and 23 in seven of the thighs in which counts could be made; being 23 right: 23 left twice, 23:22, ♂ 22:23, ♂ 22:22 three times, 22:—, 21:22, 21:21, 20:21 three times, 20:20, and 19:—. The femoral pores are large in four, medium in six (at least two of which are males), and small in five specimens.

Light, almost wholly unspotted, specimens were taken on the glaring sand south of Blythe Junction. The throats in these are cream-colored and much lighter than in other specimens; and the sides of the head are yellowish and show no dark markings. Other specimens collected among dark rocks, in washes, and on rocky hillsides exhibit the bluish gray throats, dusky shoulders, and yellowish hind quarters typical of the species. The areas between the darker spots on the neck, and the spot in front of the ear (light yellow in *C. stejnegeri* and in *C. tigris undulatus*), are in the present series dusky, and in many specimens this dusky suffusion obscures the darker markings on the sides of the neck. The dorsal spotting, striping and cross-banding seems to occur rather indiscriminately among both large and small individuals. The examples from sandy areas, as before noted, have the dorsal pattern almost obliterated. The dorsal black dashes in some of the others are in six to eight longitudinal series joined obliquely to form zigzag stripes, with the yellow ground color showing as longitudinal lines be-

tween. In other examples the black longitudinal lines are broken up into squarish patches, and in a few these patches are joined transversely in the posterior region giving a tiger-like banding.

Museum number	5513 ♂	5516 ♀
Total length (in millimeters)	335	309
Tail length (in millimeters)	246	220
Length of fourth toe (in millimeters)	25	23

The whip-tailed lizard seems to occur abundantly in the Turtle Mountain vicinity in every phase of environment, except the rocky mesa, from rocky hillside to sand dune (see table, p. 507). It was especially well represented over the rocky hillsides, where individuals ceaselessly forage, sticking their sharp noses into little piles of leaves and debris or picking up small bits of food with their active tongues. They slink about hesitatingly on the sand, with their tails dragging behind them, thus leaving a characteristic track. When running swiftly this lizard elevates its tail, so that the ground is just cleared; and the tip lashes about as the lizard runs.

Though usually timid, the whip-tails, like *Callisaurus*, seem to be almost devoid of fear when feeding. I saw two come into a room and gather crumbs from the floor while several people were about. They sometimes rest with their hind feet raised clear of the hot sand. They exhibit a tendency to burrow with their forefeet when annoyed.

The stomach of one whip-tail contained a large grasshopper, slightly chewed. Another had eaten a small beetle, a spider, and a quantity of tiny yellow ants.

Sonora episcopa (Kennicott)

Texas Ground Snake

The one specimen (no. 5549) was taken in the rocky hills four miles northwest of Blythe Junction. So far as known to the writer, this is the first record of this snake from California. The scales are in 15 longitudinal rows, the loreals are 1–1, the gastrosteges 185, the urosteges 50, the total length 405 millimeters, and the tail length 73 millimeters.

The coloration differs slightly from that given by Van Denburgh (1912, pp. 153–154) for two specimens collected at Yuma, Arizona. The head is orange (a variation also recorded by Brown, 1901) instead of the usual yellowish brown color, and is identical in tone with the "vinaceous rufous" dorsal band. The darker patches on the head

are only barely distinguishable. The dorsal stripe is three whole and two half scales wide on the body, and two whole and two half scales wide on the tail. The orange colors have turned to light pink after nine months immersion in alcohol. In the adoption of the scientific name of this and the next following species the present writer follows Van Denburgh and Slevin (1913, p. 411).

The specimen captured was found on June 8 at six P.M., coiled beside a stone in front of a hole, into which it abruptly disappeared when approached. The red colors were conspicuous in the living snake from the moment it was discovered. The stomach was apparently empty.

Sonora occipitalis (Hallowell)

Desert Burrowing Snake

The two specimens secured (nos. 5547, 5548) were the only examples of this species noted. In each the body scale rows are 15 and the loreals 1–1; other features as follows:

Nos.	Gastrosteges	Urosteges	Black bands on body	Black bands on tail	Total length in millimeters	Tail length in millimeters
5547	161	46	31	9	104	36
5548	163	41	32	10	318	53

The life-colors of this species (see Richardson, 1910, p. 383) have faded more quickly and completely in alcohol in the present specimens than in any of the other reptiles in the collection. The yellow and red bands are now, after nine months, entirely white, although the specimens have been kept in the dark.

Two of these docile little snakes were found on the gravelly, creosote-dotted plains south of Blythe Junction. One was taken late in the afternoon, the other early in the morning, and neither was active. One was caked with clay as though it had just emerged from the soil. Mr. H. A. Smith of Blythe Junction, to whom I showed one of the above examples, said he once found one of these snakes in the hard soil of his yard and some distance below the surface.

Lampropeltis boylii (Baird and Girard)

Boyle King Snake

The only specimen taken (no. 5543) shows no trace of longitudinal striping as in "*californiae*" from San Diego, Riverside, San Bernardino (Waterman Cañon), and Fresno counties. A very few of the

white scales on the sides are narrowly bordered posteriorly with brown; this may indicate a leaning toward the *conjuncta* type, described from Cape San Lucas and Yuma, Arizona (Van Denburgh, 1895, pp. 142, 143).

In the Blythe Junction specimen the loreals are distinct, there are two postoculars, the anterior temporals are three on each side, and there are nine inferior labials, of which the fifth is the largest. The scale rows are 23–21, the gastrosteges 256, and the urosteges 54 (all divided). The total length is 912 millimeters, and the tail length is 115 millimeters.

The rostral plate is yellowish, margined above with brown. All the other parts are dark brown and white. The color pattern is typical. There is a small white patch on the middle of the nape one scale behind the parietals. The body is encircled with thirty-five white rings and the tail with eight.

Only the one "milk snake" was seen in the Turtle Mountains. It was found on May 30, crawling over the rocks in a cañon bottom at about nine o'clock in the morning. An example of this species, taken in the river bottom (arrowweed association) at Needles, on July 15, 1909, was trying to swallow head-first a harvest mouse (*Reithrodontomys*) caught in a "gee-whiz" mouse trap.

Bascanion flagellum frenatum Stejneger

Red Racer

Two specimens of this variable form are at hand (nos. 5545, 5546). The scales are in 17 rows in both, and in each the anal plate is divided. Loreal fused with posterior nasal on each side in no. 5546; partly fused on left, distinct on right side, in no. 5545. Other characters as follows:

No.	5545	5546
Superior labials	7 right, 9 left	8
Inferior labials	11	11
Gastrosteges	201	207
Urosteges	110	111
Total length (millimeters)	1291	1237
Tail length (millimeters)	341	327

Color descriptions of this subspecies by Cope (1898, p. 801), Stejneger (1893, pp. 208–209), and Van Denburgh (1897, p. 187) taken probably from preserved material, do not mention the vivid red color of this snake. In both of the present examples there are traces of at

least three black cross-bars on the nape, and no. 5545 has a series of lighter scales in regular transverse intervals down the back on the anterior half of the body. Both specimens are heavily marked with brown and red spots about the face, neck, and throat.

The red racer seems to be the most generally distributed snake on the Colorado Desert. It occurs on mountain and plain alike, and is far swifter in movement than any other desert snake. The two present examples were taken at the Horn Mine near a tent floor under which they had apparently been living.

Crotalus mitchellii (Cope)

Pallid Rattlesnake

Three specimens (nos. 5540, 5541, 5544) of this desert species were captured near the Horn Mine. In scutellation and coloration these examples show departure from some of the typical characteristics of *mitchellii* and seem to approach to a certain extent those of *tigris*. In no. 5540 the rostral is in contact with the anterior nasals on both sides, but on the left a small scale has started to split off from the nasal between the latter and the rostral. In the other two specimens the rostral is separated from the anterior nasals by one row of three scales on each side. Rostral higher than wide in no. 5540, equilateral in no. 5544, and wider than high in no. 5541. Scales on body all keeled; in 23 rows in no. 5541, and in 25 rows on the other two specimens. Supraoculars striate and rugose. Three rows of scales between suborbital chain and labials. Other characters as follows:

Museum Number	5540	5541	5544
Rows of scales between supra-oculars	7	6	5
Superior labials	17	15	16
Inferior labials	16	17	17
Gastrosteges	179	183	179
Urosteges	18†	21†	19‡
Total length (in millimeters)	653	773	616
Tail length (in millimeters)	41	55	47

† Last one divided.

‡ First and last three divided.

The color varies widely. In no. 5540 the transverse bands of ground color are light pink, the muzzle greenish, the top of the head pinkish yellow speckled with yellow, and the sides of the head gray over the temporal region and corner of the mouth; dark patches on

back indistinct, brown; sides gray; a few scales surrounding darker patches on back, bluish gray; underparts whitish; a broad light subocular stripe including six of the upper labials.

No. 5541 has more red in the coloration of the sides, and the lighter dorsal bands are flesh pink. Gray predominates in the dorsal coloration, and the pink ground color becomes tawny on the posterior end of the body. Distinct reddish brown bands on posterior third of the body; anteriorly each of these bands splits into three transverse blotches, the outer two being small, and the middle one large as in *tigris*. Belly white; lateral edges of gastrosteges in median abdominal region speckled with red and gray. Light area below eye, covering five upper labials. No. 5544 is in the red phase. The coral red of the top of the head and back almost obscures every other marking, but the dorsal bands can be made out because of their darker shade, near russet vinaceous. The pink color becomes yellowish near the tail; the latter is marked by seven fairly distinct blackish bands which do not meet below. The sides and top of the head are obscurely stippled with gray. No light markings below or behind eye. In all three specimens the sides of the head do not exhibit the postocular stripe common to so many species of rattlesnakes (see Stejneger, 1895, pp. 423–424).

Only the three pallid rattlesnakes taken were seen; two of these were in a rocky wash at the Horn Mine, and one (no. 5541) was beneath a dead palo verde in a wash about a mile from the foot of the mountains. The stomach of no. 5544 contained a Stephens cañon mouse (*Peromyscus crinitus stephensi*). Since this rodent is wholly nocturnal, the instance might be taken as showing nocturnal habits on the part of the snake.

Crotalus cerastes Hallowell

Sidewinder

One horned rattlesnake (no. 5542) was captured in the drifting sand near Blythe Junction. This specimen has the anterior and posterior nasal plates divided on the right side and united on the left. One internasal is present on each side. There are 13 superior and 13 inferior labials, 143 gastrosteges, and 24 urosteges of which the posterior four are divided. The total length to the base of the rattle is 504 millimeters, and the tail length 39 millimeters. There is a wart-like growth on one side near the neck, consisting of eight elongated scales arranged in rosette fashion.

The writer is by no means convinced that this rattlesnake is exclusively nocturnal in habits as suggested by Meek (1905, p. 18). Both at Needles and near Blythe Junction individuals were traced by the characteristic tracks in the sand. Each was found closely coiled in a symmetrical pad and partly buried flush with the surface in the hot sand right out in the noonday sunshine of midsummer. In neither case were the snakes easily seen, as they were of the exact color of their sandy surroundings. Both, though alert, allowed themselves to be noosed without moving away or doing more than rattle feebly. That they eat the diurnal lizards *Uta* and *Cnemidophorus* (see Van Denburgh and Slevin, 1914, p. 429) is an evidence of daytime activity.

Transmitted August 20, 1915.

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PLATE 19

Map of Turtle Mountain region, southeastern California, showing animal environments.

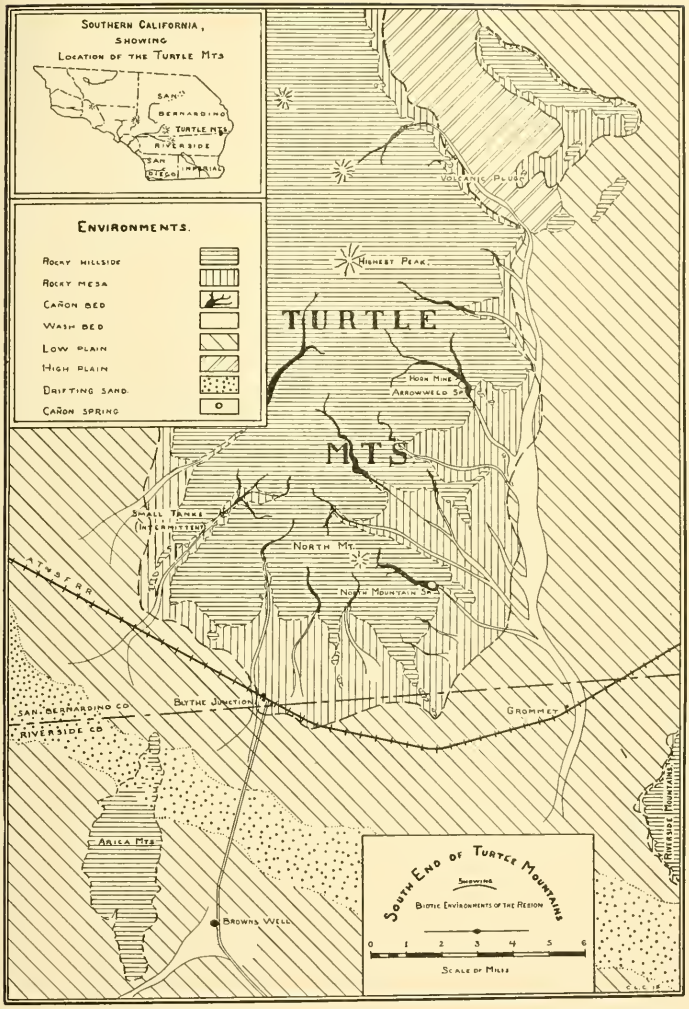
SOUTHERN CALIFORNIA, SHOWING LOCATION OF THE TURTLE MTS
SAN BERNARDINO
TURTLE MTS
RIVERSIDE
SAN DIEGO
IMPERIAL
ENVIRONMENTS.
ROCKY HILLSIDE
ROCKY MESA
CAÑON BED
WASH BED
LOW PLAIN
HIGH PLAIN
DRIFTING SAND
CAÑON SPRING
VOLCANIC PLUG
HIGHEST PEAK
TURTLE
HORN MINE
ARROWWEED SP
MTS.
SMALL TANKS (INTERMITTENT)
NORTH MT.
NORTH MOUNTAIN SP
A.T.&S.F.R.R.
BLYTHE JUNCTION
GROMMET
SAN BERNARDINO CO.
RIVERSIDE CO.
ARICA MTS
BROWNS WELL
RIVERSIDE MOUNTAINS
SOUTH END OF TURTLE MOUNTAINS
SHOWING
BIOTIC ENVIRONMENTS OF THE REGION
0 1 2 3 4 5 6
SCALE OF MILES
C.L.C. 19

PLATE 20

Fig. 2. High plain environment near volcanic plug at south end of Turtle Mountains, San Bernardino County, California. *Yucca mohavensis* in foreground and middle distance.

Fig. 3. Low plain environment near Blythe Junction, Riverside County, California. *Dipodomys deserti* burrows in foreground, sand dunes in distance.

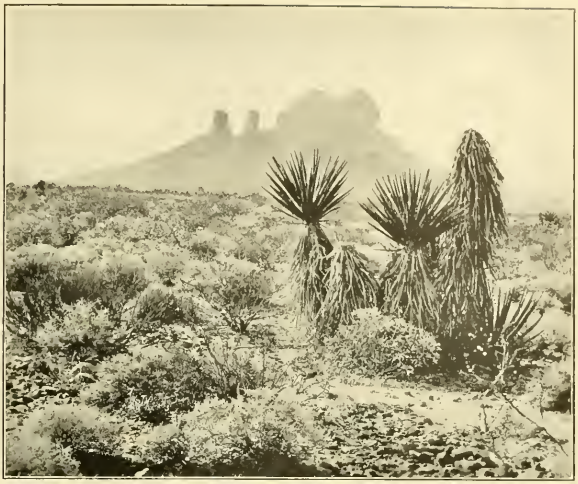

Fig. 2

Fig. 3

PLATE 21

Fig. 4. Drifting sand environment near Blythe Junction, Riverside County, California. Home of *Uma notata;* kit fox scratchings, and burrows of *Citellus tereticaudus,* in foreground.

Fig. 5. Small wash in rocky mesa environment at south end of Turtle Mountains. Caves in foreground inhabited by *Neotoma,* and by *Sceloporus magister.*

Fig. 4

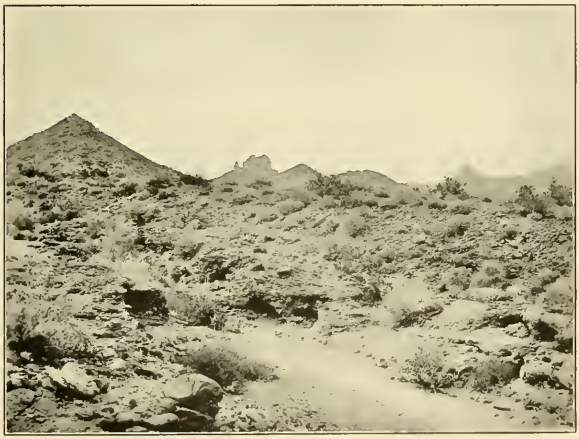

Fig. 5

PLATE 22

Fig. 6. *Uma notata*, from specimens. Dorsal view from no. 1285, Mus. Vert. Zool.; ventral view from no. 1286, Mus. Vert. Zool.

Fig. 7. *Uma notata*, from life, showing posture when alert

Fig. 6

Fig. 7

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